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[SECOND SERIES.]

ART. I.—*A Monograph of the Ancient Monuments of the State of Kentucky;* by E. G. SQUIER.

KENTUCKY abounds in ancient earthworks, which partake very much of the character of those bordering on the Gulf of Mexico. Many of the enclosures are manifestly defensive, but the larger proportion, like those of Ohio, were probably dedicated to sacred purposes. The latter, however, are seldom of large dimensions; and none, so far as we are informed, assumed the remarkable combinations which are to be observed in the Scioto and Miami valleys. They are, for the most part, small circles and squares, —the former greatly predominating in point of numbers. The mounds, on the other hand, are usually more regular and perhaps of larger average dimensions than those to the northward of the Ohio. The rectangular and terraced mounds, in particular, are comparatively numerous, and are often of great size. Those which are low, and cover large areas, are known as "*platforms.*"

Few of the Kentucky works have ever been surveyed, although many have been noticed and described with greater or less fullness, at various times. Prof. Rafinesque, in his notes, has indicated the localities of a great number, but has failed to give us any very clear conception of their character. In his fanciful introduction to Imlay's History of Kentucky, he estimates the number of groups of works within the state at six hundred.*

* For "Ancient Monuments of the Mississippi Valley," I have in the following pages substituted the abbreviation "A. M. of M. V." For the name of Rafinesque, from whose confused notes most of the facts were obtained, simply the initial "R."

Fayette County.—1. An irregular enclosure or fortification occupying a peninsula formed by the Elkhorn river, at its junction with the Town fork, seven miles from Lexington. The river passed through one portion of the enclosure,—a feature unknown in any other work with which we are acquainted. Near this work are several small enclosures and a number of large mounds.

A plan from a survey found among the Rafinesque papers, purporting to have been made in the year 1790, is engraved in A. M. of M. V., Plate IX, No. 3. Another plan, corresponding with this in every essential particular, is published in Collins' History of Kentucky. It is possible that in the subdivisions which have been made, this work now falls in Woodford county.

2. An irregular enclosure of eighteen acres area, on the South Elkhorn river, six miles distant from Lexington. The Cally Ford road passes through it. The walls are low; ditch exterior. A plan, from what appears to be a minute survey by Rafinesque, is published in A. M. of M. V., Plate XIV, No. 4.

3. Another irregular work, of similar character but larger size, is situated not far from that last described, on the South Elkhorn river. It has an area of twenty-five acres. A plan, from a survey by Rafinesque, is published in A. M. of M. V., Plate XIV, No. 3.

5. Rafinesque mentions a polygon, of seven unequal sides, and 4800 feet in circumference, in the vicinity of Lexington, but does not indicate its exact locality. According to this authority the embankment, at the time of his writing, was from eight to sixteen feet in height.

6. Rafinesque also notices an enclosure near the mouth of the Elkhorn river, six hundred feet in circumference; parapet two feet high; ditch interior to the embankment. Within this enclosure is a "platform," seventy feet square; also a mound four feet high and one hundred and seventy-five in circumference. Various other works, "causeways, platforms, and mounds," are mentioned as occurring in this vicinity.

Woodford County.—1. At Cynthiana, on the south bank of Licking river, a small circular work, 570 feet in circumference. A similar work is found on the lands of Mr. H. Miller, on the Licking river.—(R.)

2. On the farm of Mr. W. Anderson, also on the banks of Licking river, is a group of six mounds; two of which have embankments around their bases. The circumference of the largest is six hundred feet, height thirty feet.—(R.)

3. An octagon terrace or "platform" occurs near Lovedale.—(*Figured and described, A. M. of M. V., p.* 176.)

Jessamine County.—1. A large mound one mile southeast of Nicholasville. It is elliptical. Several graves lined with stones have been found in mounds, in this vicinity.—(R.)

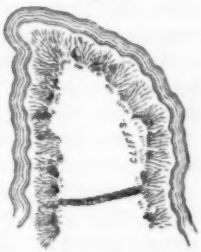
2. A large collection of Indian graves, four miles from Buck's Tavern, and also on a bluff, to the right of the road, near Grimes' Mills.—(R.)

Clay County.—1. A square stone work, about ten miles north-east of Manchester, on the road to "Red Bird river" salt works. Sides each measure about one hundred feet in length.—(R.)

2. At the salt works on Goose creek, in this county, are abundant evidences that the salines were once worked by the Indians,—broken pottery, pestles, etc., being found here in abundance.

Larue County.—An interesting work occurs in this county. "It is situated upon a level bottom of twenty or more acres, near its extreme point, where the creek makes a sudden bend. The creek is here about fifteen yards wide, with abrupt banks, six feet high. The walls have fallen or may have been thrown down, and are now about three feet high, covering a space twenty feet wide. They may originally have been seven feet wide by six feet high. The distance from gateway to gateway is a little upwards of one hundred feet, and the area enclosed is not far from twenty square rods. The ground is somewhat lower within than exterior to the walls. These walls seem to have been faced inside and out with dry masonry, filled in with smaller stones. There are still two pieces of the inside wall standing, one at the southwest angle of the work, the other at the north side of the eastern gateway. The stones have evidently been fractured by percussion, and now lie edges up,—clearly the fallen faces of the original walls. It may be well to remark that the bottom land here presents no stones of any sort, and is an alluvial black loam. In respect to its antiquity, it can only be said that it is covered with a primitive forest, and that a pine tree nearly seven feet in circumference is growing on the wall."—*Collins's Kentucky*, p. 398.

Fig. 1.



Trigg County.—1. At Canton near Boyd's landing on the Cumberland river, an enclosure nearly square, 7500 feet or about a mile and a half in circumference. The wall is from three to five feet high; ditch exterior. It encloses nine mounds of large size. One is rectangular, truncated, twenty-two feet high, one hundred and fifty long and ninety broad.—(R.)

2. There are many mounds of various shapes and sizes in this county. Two miles south of Canton, on the top of a high rocky bank of the Cumberland river, are three mounds, each about ten feet high. An oblong square "teocalli," or truncated mound, also occurs upon the bank of the Cumberland, not far from the above named mounds. There are two conical tumuli, one at each end of this structure. Several broad flat mounds or "platforms," are found near the junction of Little river with the

Cumberland. They contain bones, covered with stones. There is a conical mound here, twelve feet high. Near the line of Christian county, are many others.—(R.)

Logan County.—1. On Muddy Creek, ten miles northwest from Russleville, a quadrangular enclosure, with an exterior ditch, and a gateway opening towards the creek, on the north. It encloses two mounds, each about twelve feet high and truncated. —(R.)

2. On Muddy Creek, six miles from Russleville, a circumvallation on the east side of a bluff of freestone, one hundred feet in height. It encloses one acre and a half; ditch exterior; parapet three feet high; with gateway opening toward the river. Below this work is a long row of mounds, on the bank of the creek.—(R.)

3. Near "Clay's Lick," on the west bank of Whippoorwill creek, is a raised "platform," 400 feet in circumference and four feet high. There are several broad excavations near by.—(R.)

4. Ten miles northeast of Russleville, on Gasper river, is a square enclosure with a mound in the center.—(R.)

5. A few miles southeast of Russleville, in what is called the "barrens," are a great number of small mounds, covering several hundred acres. Many have been excavated and numerous relics recovered. Some very interesting ones formerly occupied the present site of Russleville. The Masonic Hall was built upon one of them.—(R.)

Harrison County.—1. Near Cynthiana, on the Licking river, an enclosure 800 feet in circumference; embankment ten feet high; ditch interior. In the center is a mound 342 feet in circuit. A gateway opens to the southwest. In this direction, seven hundred feet distant, is a mound, now the site of a dwelling house. —(R.)

Bath County.—Near Bloomfield, on the road from Mount Sterling to Upper Blue Lick, is a large square enclosure of many acres.—(R.)

Clarke County.—Near Boonsborough, several enclosures and a number of mounds. At Indian town, an irregular work supposed to be defensive.—(R.)

Adair County.—On the "Long Bottom" of Cumberland river, several flat square mounds or platforms.—(R.)

Hart County.—Near Williams' Mill, an enclosure of considerable size, circular in shape. In a spring near by, have been found a number of large conch shells—(*Pyrula perversa?*)—(R.)

Mason County.—Three miles from Washington, a singular platform, figured and described, A. M. of M. V., p. 176.

Union County.—Several caves containing human bones are found in this county. Eight miles from Morgansfield is a flat rock covered with carvings of human feet of all sizes, wolf tracks, etc.—*Collins's Kentucky*, p. 540.

Hopkins County.—Within four or five miles of Madisonville, a hill work, enclosing ten acres.—*Collins's Ky.*, p. 250.

Carroll County.—An ancient enclosure ten miles from the mouth of the Kentucky river, square, containing one acre, with heavy walls.—*Collins's Kentucky.*

Garrard County.—There are a number of enclosures in this county, mostly circular, and an abundance of mounds. Some large ones occur near Lancaster, and there are others on Paint creek.—(R.)

Davies County.—An enclosure at the mouth of Green river, on the Ohio. Another on an island in the Ohio, somewhat lower down.—(R.)

Greenup County.—Two groups of works on the Ohio, opposite the mouth of the Scioto river. One consists of a series of concentric circles, with a truncated terraced mound in the center, and with an avenue leading to a point on the bank of the river, opposite which it is resumed, connecting with the Portsmouth works five miles distant. The other group is eight miles lower down the river, and consists of a large square of fifteen acres, with avenues leading off from the sides, each 2,100 feet long.—*See account, plans, &c., in A. M. of M. V.*, p. 77, Plates XXVII, XXVIII.

Lewis County.—An ancient enclosure on the banks of the Ohio river.—(R.)

Rock Castle County.—About three miles northwest of Mount Vernon, a row of Indian graves, forming a straight wall or ridge of limestone piled up. It is two hundred feet long, and between three and four high. Abundance of human bones are mixed with the stones.—(R.)

Knox County.—An enclosure on the Cumberland river, three miles above Barbersville, containing three acres. Numerous mounds in the vicinity.—(R., *and also Collins's Ky.*, p. 250.)

Whitley County.—An enclosure on a bottom of the Cumberland river between Meadow and Flat creeks. Here are numerous remains, and among them a square mound or "teocalli," three hundred and fifty feet long, one hundred and fifty broad, and twelve feet high. Similar remains are found on Blake's fork of Watts's creek, on Lime Camp creek, and at other points within the county.—(R.)

Shelby County.—On the road from Frankfort to Bardstown, about twenty-five miles from each place, a square enclosure of one acre, now occupied by an orchard. At Shelbyville is a large mound.—(R.)

Mercer County.—1. An ancient work, four miles above Harrodsburgh, on Salt river; another a mile and a half above: each quadrangular.—*Collins's Ky.*, 452.

2. An ancient enclosure in the "horse shoe" bend of Dick's river, with two square bastions and a gateway on the narrow ridge of the isthmus. The wall twenty feet high from the bottom of the ditch. Several large mounds near the Shawnee Spring.—(R.)

Lincoln County.—On Dick river, three miles from Wilmington, a square mound, six hundred feet in circumference, five feet high and truncated. Many relics found in the vicinity.

Caldwell County.—On Donaldson fork of Treadenwater river, is a work constructed by building a strong stone wall across the isthmus of a peninsula formed by a bend in the stream. The bluff is about one hundred feet high. The wall is about one hundred and fifty feet long, four high and very broad. The enclosed area is something less than an acre.—(R.)

Scott County.—1. A square enclosure on Mr. Wither's land, near the mouth of Dry run, a tributary of the Elkhorn.—(R.)

2. A ditch across the neck of a peninsula formed by a bend in the Elkhorn river, north bank, between Thompson's and Payne's mills.

3. Some works on the banks of Frankfort river, four miles from Georgetown, near Craig's Mills.

Bracken County.—1. Large ancient cemetery on a "bottom" of the Ohio river near Augusta. Said to be two miles long.—(R., *also Collins's Ky.*, p. 180.)

2. A quarry of flint, anciently worked by the Indians.—(R.)

Gallatin County.—On a hill, at the mouth of the Kentucky river, a large enclosure.—(R.)

Boone County.—1. A large square work, on the bank of the Ohio, near Bellevue, below the mouth of the Great Miami river. Also some large mounds between Burlington and North Bend.

2. An enclosure a little above the town of Petersburgh. The wall extends from the abrupt bank of the Ohio, to the precipitous bank of Taylor's creek. It is four feet high. The area of the enclosed ground is twenty-five acres.—*Collins's Kentucky*, p. 180.

Campbell County.—Near Covington, between Licking river and Willis creek, an elliptical platform, eight feet high and seven hundred and fifty feet long, commencing in a large conical mound, twenty-five feet high. A large mound is situated on the top of "Big hill," north of Big-bone Lick. It is elliptical in shape, one hundred and fifty feet long, depressed in the center.—(R.)

Livingston County.—1. A large enclosure and other monuments at the mouth of the Cumberland river.

2. Near the mouth of Hurricane creek, three-fourths of a mile from the Ohio river, an octagon enclosure, 2852 feet in circumference, containing four mounds. There are several other monuments of small size, in the vicinity.

3. A circumvallation on the farm of Mr. Jones, two miles from Lancaster. Just outside the gateway is a spring, in which were found eighteen large and twelve small shells, resembling the conch. Another enclosure occurs on the farm of Mr. Kenneday near by, where fifteen similar shells were found.—(R.)

Jefferson County.—A polygon enclosure at Locust Grove.—(R.)

Harlan County, (formerly Knox.)—A large mound at Mount Pleasant, upon which the Court house is built. It gave name to the place. It is circular, truncated, and was originally twenty feet high. A large mound occurs at a place called Cumberland Gap, with many smaller ones around.

Christian County.—There are numerous traces of an ancient population in this county. At Licking creek, six miles southeast of Hopkinsville, are many embankments, mounds, etc. A great number of round holes, with raised edges occur here. A number of large mounds formerly existed in Hopkinsville, upon the largest of which the Court house was erected. There are yet many mounds in the vicinity.—(R.)

McCracken County.—Mounds are especially abundant in this county. There is a large square one, truncated, fourteen feet high and twelve hundred feet in circumference, a few miles below the mouth of Clark's river, a little distance from the banks of the Ohio. Below Hunting creek, on the elevated lands, one-fourth of a mile back from the Ohio, are five parallel rows of mounds, of unequal sizes, placed close together. Just above fort Jefferson, on the Mississippi, are many little mounds, and other monuments.

Pendleton County.—Near Falmouth, an ancient enclosure, on elevated and commanding ground, between two rivers. It is circular, with four openings at right angles to each other and corresponding very nearly with the cardinal points. There are numerous mounds in the vicinity.—*Collins's Kentucky*, p. 494.

Warren County.—1. An ancient work on the east bank of Barren river, one mile east of Bowling Green. It is an irregular octagon, 1,385 feet in circumference, with an exterior ditch, and a small mound at each angle. There are two rectangular, truncated mounds within the walls, the largest of which is one hundred feet long and fifty wide.—(R.)

2. There is also a large hill work near by that just mentioned. It occupies a bluff inaccessible except at a single point. It is square, and has a line of mounds extending from it for more than a mile, gradually becoming smaller as they recede.—*Collins's Kentucky*, p. 542.

Hickman County.—On the bank of the Mississippi, a few miles below "Ironbanks," is a large and beautiful mound. It is four hundred and fifty feet long, thirty broad at top, and ten high. Bones are found within it.—(R.)

Montgomery County.—Great numbers of ancient monuments occur in this county, some of which possess peculiar interest.

Mounds are particularly numerous, and are remarkable for their size and regularity of construction. The seat of justice of this county, Mt. Sterling, derives its name from a large mound which formerly existed within its corporate limits. This mound was cut down in 1846, and was found to contain human bones, copper plates, beads, bracelets and other ornaments.

Rafinesque, in a published letter addressed to Hon. Thomas Jefferson, dated "Transylvania University, August 7, 1820," gives an account of six groups of ancient works found in this county. They all occur in the vicinity of Mount Sterling. The account is herewith presented. The plan of the first group described is published in A. M. of M. V., Plate xxxiii, No. 1.

"Group I.—A compact group of monuments on the west side of Brush creek, a branch of Slate creek, six miles S.E. from Mount Sterling, between Montgomery's farm, and a Methodist meeting house, which has taken from them the name of 'Fort Meeting-house.' They are on a fine level high ground, not far from the creek, and which has never been cultivated as yet: they are five in number.

"No. 1. The nearest to the meeting-house towards the south is a square enclosure, 400 feet in circumference; the sides are equal, corresponding to the cardinal points. The parapet is 15 feet broad, four feet high from the bottom of the inside ditch, and two feet above the level of the ground. There is a gateway due east, in the middle of the eastern side. The central area is a small *oblong* square, greater length from east to west, 35 feet; breadth 25.

"No. 2. Is about 200 yards east from No. 1, and at nearly an equal distance from Nos. 3 and 4, forming with them the center of a figure shaped like the letter Y. It is a singular elliptical mound; circumference 270 feet, height nine feet, top elliptical, 100 feet round with raised ends, and a small central rounded mound about one foot high, over which were lying, in a square form, some loose flat stones. A short appendage to the south connects it with a small circular mound, 100 feet round and four feet high.

"No. 3. Is N.E. from No. 2. It is a circular enclosure, 510 feet in circumference. Parapet 20 feet broad, five feet high over the ditch which lies inside. Gateway due east, 15 feet broad. Area perfectly square, 300 feet in circumference, or 75 feet on each side. The sides correspond with the cardinal points. There is a small circular mound, 42 feet in diameter, and one foot high, on the western side of the area opposite the gateway.

"No. 4. An hexagonal enclosure, south of No. 3, and S.E. from No. 2. Sides equal, each 50 feet. Whole circumference 300 feet. Parapet 25 feet broad, four feet above the inside ditch. Gateway at the eastern corner 15 feet broad. Area square, sides equal and 40 feet long, corresponding with the cardinal points.

"No. 5. An oblong mound, lying south of No. 1, on the opposite side of Brush Creek. I have not measured it.

"Group II. A scattered group immediately in the vicinity of the town of Mount Sterling, on each side of Hinkston creek. It consists of six monuments.

"No. 6. A simple enclosure, one mile east of Mount Sterling, on Smart's farm, in a fine level high ground, on the east side of Hinkston creek, between the Mud Lick road and the Salt-works road. It consists of a simple ditch without visible parapet. The form is a decagon nearly regular; but two sides appear to be somewhat shorter, or of 75 feet, while the eight others are all 125 feet. Total circumference 1150 feet. Ditch about two feet deep and six to eight broad; but often obliterated. No gateways could be perceived; they may have been where the ditch is not easily seen. There are two small eccentric circular mounds in the inside towards the west. Largest 105 feet in diameter and two feet high. Smallest 50 feet in diameter and one foot high, and near to the ditch. This has all the appearance of a very remote origin. It is in the woods and has never been ploughed.

"No. 7. A circular mound, about 350 feet in circumference, and 20 feet high, situated half a mile N.W. of No. 1, on the east or right side of Hinkston creek.

"No. 8. A circular mound 400 feet in circumference and 24 feet high, lying in the town of Mount Sterling, to which it has given its name. It has been partially excavated on the side and the summit, and found to contain bones mixed with the earth.

"No. 9. A simple enclosure about one mile N.N.E. from Mount Sterling, round the hill on the west or left side of Hinkston creek and the Flemmingsburg road. It is a polygon, but whether a regular or irregular one, is rather difficult to ascertain; I could not even trace the number of sides. It is in an iron weed brake in the woods; but the ground being on a slope, the rains have filled up the ditch in many parts; towards the west the ditch is yet four feet deep. I was told that it was much plainer about 20 years ago; a few years make, therefore, great alterations, even without the help of the plough. I have traced, however, the outlines, and reckoned the circumference at about 1,500 feet.

"No. 10. A circumvallation in Read's cornfields, about one mile N.N.W. of the town, near a small branch of Hinkston Creek. It has been ploughed up for many years, and has nearly disappeared; I could not trace its circumference, but it was very plain a few years ago.

"No. 11. Singular mound, about one mile north from Mount Sterling, near the Blue Lick road. It is of an oval shape; smallest end to the south, where it is lower and only 14 feet high, while it is 24 feet high to the north. Circumference 575 feet. Summit somewhat inclined, 135 feet long, and 40 broad, with a circular concavity to the northern extremity.

"Group III. Compact, on level ground, about two miles north from Mount Sterling, on Jameson's farm, and on the left of the Paris road. Sommerset creek is half a mile to the west, and there are no springs in the immediate neighborhood at present. It consists of five mounds.

"No. 12. A large and singular circular mound 32 feet high, surrounded by a circular parapet and intermediate ditch, interrupted by four large gateways, 50 feet broad, equal in size and distance, looking towards the N.E.—N.W.—S.E. and S.W. The four parts of the parapet are therefore opposed to the four cardinal points; whole cir-

cumference 800 feet, ditch four feet deep. Central mound about 500 feet round. Summit 120 feet round and somewhat concave.

"No. 13. Similar mound, smaller, only 15 feet high, and 130 feet distant from No. 12, towards S.E. It has also four gateways, but they are N.—E.—W. and S.W., and the northern one is much the largest and inclined in the shape of an ascent; breadth 40 feet, the others 30 feet. Circumference of the parapet 430 feet; ditch three feet deep. Summit small, somewhat concave.

"No. 14. Simple mound, without ditch or parapet; 250 feet in circumference, and 10 feet high. It lies 80 feet S.W. of No. 13.

"No. 15. A similar mound, lying 312 feet east of No. 13. It is six feet high, and 165 feet in circumference.

"No. 16. Another mound, 80 feet from No. 14, due east. It is eight feet high and 200 feet in circumference.

"Group IV. Compact and remarkable for its size, high parapet, etc., although it is situated in fields which have often been ploughed. It is on Johnson's farm, three miles north of Mount Sterling, on the east bank of Sommerset creek, and on a high hill with a level summit. It contains an enclosure and four outward mounds.

"No. 17. A large circumvallation, quite circular and 1150 feet round, with a high parapet, a deep inside ditch, a single gateway due east, and a central mound. Parapet 55 feet broad, four to five feet above the ground, and eight to twelve feet above the ditch, inside slope 25 feet. Gateway 50 feet broad. Area three feet high above the ditch. Central mound 75 feet from the ditch, 206 feet in circumference and three feet high. Many remains of pottery, fine pipe-heads, and several other implements have been found in ploughing the area.

"No. 18. Large circular mound, 60 feet due north from No. 17, and united to it by a raised platform. It has two spurs, or oval inclined appendages to the north and west; the northern one is the larger. Circumference with the spurs 800 feet, without 600. Height 22 feet, summit level with a small central concavity.

"Nos. 19, 20 and 21. Three outward and unconnected mounds, lying irregularly to the S.E. of No. 17. The largest, No. 19, is eastward of No. 20; it is 220 feet around, and five feet high.

"No. 20 is in the middle and only 50 feet from No. 17. It is only 175 feet in circumference and three high.

"No. 21. The smallest and western, is near No. 20, and nearly south from No. 17. It is only 150 feet round and two high.

"Group V. Is quite scattered, and contains three enclosures with two mounds, lying near Sommerset creek, about four miles to the northward of Mount Sterling.

"No. 22. Square enclosure on John Higgins's farm, on the south and left side of Sommerset creek. Each side equal, 150 feet long, and corresponding with the cardinal points; gateway single, due east, 30 feet broad; area square, each side 90 feet long. The parapet is now only one foot high, the ground having been repeatedly ploughed. It was originally three feet high.

"No. 23. A circular enclosure, lying on James Higgins's farm, 300 yards from No. 22, towards the N.W.; but on the opposite side of Sommerset creek, in a corn field, and in the flat bottom of the valley.

This is a singular instance, since nearly all the ancient monuments are on high ground. The place is sometimes overflowed, which, however, is owing to the bed of the creek having been raised of late by alluvium; circumference 800 feet; gateway S.E. directed towards No. 22. Parapet only one foot high, and often obsolete; it was three feet high before being ploughed; but it may easily be traced by the growth of corn on it, being much lower and poorer than inside and outside. This happens in all instances, the ground of the parapets having been made up by throwing on them different and often gravelly earth, taken from the ditch or some deep place.

"No. 24. A large circular enclosure on Colonel Williams's farm, nearly a mile S.W. from No. 22, and near a branch of Sommerset creek called Higgins's branch. I did not visit it, because it was represented to me as lying in several fields which have been under cultivation for 20 or 30 years, and to be therefore very difficult to trace; but it is said to consist of 10 acres of ground, and to have been formerly very distinct.

"No. 25. A mound on Moses Higgins's farm, S.E. of No. 22, and between Sommerset creek (left bank) and Higgins's branch. Circumference about 150 feet, and five high.

"No. 26. Another mound 160 feet in circumference and six high, west of No. 22, about half a mile distant, and near Grass Lick creek.

"Group VI. A small one, consisting of an enclosure and a mound, situated on a high hill in John Wilson's farm, about five miles N.W. from Mount Sterling, above the junction of Aaron's run and Grass Lick creek, and on their left side near Duncan's mill, in a corn field.

"No. 27. A circular enclosure, 1100 feet in circumference. Parapet 40 feet wide, four feet high above the ditch, two above the ground. Ditch 20 feet broad, and inside as usual. Gateway towards the S.E. The ditch was six or eight feet deep formerly.

"No. 28. A circular mound, joining No. 27, and lying to the N.E. Circumference 225 feet, height five feet at present; but it was much higher before being ploughed."

Prof. Rafinesque concludes his notice of the above monuments with the following observations:

"From the above descriptions, it may safely be surmised that each group of monuments belonged to a particular town, and that there were therefore six towns, within the same space of ground, where only one exists at present, whence it might be conceived that the ancient population was there six-fold the actual one.

"From the rapid decay, or rather diminution of height in these monuments, even without the help of the plough, it is evident that they must all have been formerly much higher, with deeper ditches, &c.; therefore much more remarkable and difficult to raise.

"Allow me, besides, to venture a few peculiar suggestions, respecting their ultimate use, which may be considered as a probable hypothesis.

"1. I conceive that each group was surrounded by a town, particularly the compact and complicated groups.

"2. The circular enclosures with outward parapets, were probably temples dedicated to the sun, like those of the Natchez nation.

"3. The square enclosures might have been the palaces of their kings or chiefs, who were called children of the sun, as in Peru, and among the Floridans, Natchez, &c.; or perhaps the council houses, places of meeting for public purposes.

"4. All the mounds are evidently barrows or sepulchral monuments, and natural appendages to temples, as our church-yards are to our places of worship: but No. 12 and 13, by their peculiar enclosures and avenues, must have been the tombs of great kings, heroes, priests or queens, who may have been worshiped after death. Similar apotheoses were common among many ancient nations.

"5. The use of Nos. 4 and 6, is more problematical; but must have been analogous, owing to the connection with mounds. Else No. 4 may have been used for civil purposes, and No. 6 for military ones, as likewise No. 9."

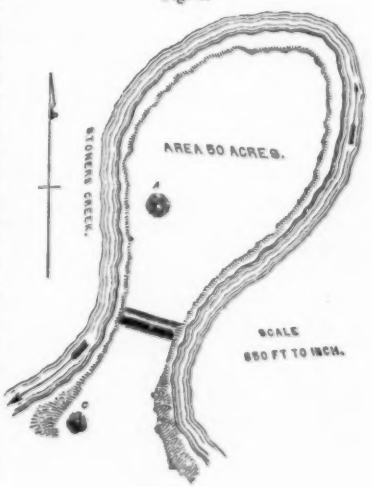
Bourbon County.—1. At the junction of Flat Run and Stoner's creek, an irregular enclosure, containing an area of twenty-one acres. A number of mounds and excavations occur within the walls, together with other remains, consisting of raised outlines, two or three feet broad and one foot high. The latter are called "remains of dwellings" by Rafinesque. Twenty of these are found within, and fourteen without, the walls. A Plan is published in A. M. of M. V., Plate XIII, No. 1.

2. A large enclosure near "Ruddle's Station," on Licking creek, 7450 feet in circumference. Several considerable circular and semi-circular works also occur in this vicinity. One of these is situated three miles from Paris, on the Millersburg road.

3. On the road from Paris to Mt. Sterling, near Gen. Fletchers', an enclosure of large size.—(R.)

Fig. 2 is a plan of an ancient work, also situated on Stoner's creek, one and a fourth mile below the town of Paris, Bourbon county. At this point the creek makes a large bend; across the isthmus of the peninsula thus formed is carried a ditch and wall, completely cutting off approach in that direction. The area enclosed by the creek and wall is about fifty acres. The letters *a* and *c* indicate mounds; the latter occupies the summit of a commanding cliff. "It is said that a causeway was perceptible at the period of the settlement of

Fig. 2.



the country, extending from this work to a large mound one and a half miles to the westward. This mound is one of a chain which extends quite across the county in a northwest direction; for telegraphic purposes their position could not have been better chosen by the most skillful engineer."

There are a number of highly interesting works of similar character in the neighborhood of those above described. At the junction of Stoner's and Hinkston's creeks is a small circle with gateways opening toward the cardinal points. Three miles distant, on Hinkston's fork, is a similar work, and a number of mounds. Besides these remains, there are here many other vestiges of an ancient population. Numerous graves are to be seen upon all the water courses; sometimes they occur singly, but usually in groups. Single graves are generally indicated by broad flat stones, set in the ground edgewise around the skeleton. When a number of skeletons are deposited together, a rude wall seems to have been raised around them, and then covered with other stones. A large cemetery and numerous traces of an ancient town are to be found near the junction of Pretty-run and Strode's creek. Thousands of human bones are here found scattered indiscriminately over a large area, just beneath the surface of the soil. Five miles below Paris, on Stoner's creek, a cave has recently been discovered, containing a number of skeletons.—*Collins's Kentucky*, p. 193.

Allen County.—1. One of the most remarkable defensive works in the state of Kentucky, occurs on the confines of Tennessee, in the western part of Allen county, thirteen miles from Scottsville and eighteen from Bowling Green. "The fortification is at once romantic and impregnable, presenting one of the strongest military positions in the world. At this place, Drake creek makes a wide bend, running one mile and then returning to within thirty feet of the spot where the bend may be said to commence. The partition which divides the channels of the creek at this point is of solid limestone, thirty feet thick at the base, forty feet high, six feet wide at the top, and six hundred feet in length. The top is level and covered with small cedars. The area included within the bend of the creek is to the eastward of this narrow pass, and contains about two hundred acres of land, which rises from the creek in a gradual ascent of one hundred feet, when it forms a level promontory. The summit of this which is leveled, is covered by a rectangular enclosure consisting of a wall and ditch, and having an area of about four acres. In the rear of this are many small mounds. The only approach to this work is over the main causeway above described, tall cliffs intercepting all access from the opposite banks of the stream."—*Collins's Kentucky*, p. 167.

2. A cave in which were found a large number of marine shells. One was eighteen inches long, cut longitudinally in the middle, with a small hole near the smaller extremity.—*Ib.*, p. 167.

3. Mounds with stone graves in them.

Barren County.—Twelve miles southwest of Glasgow are many small oval mounds, placed fifty yards apart so as to form a circle, 1200 or 1500 feet in circumference. They appear to have sustained structures of some kind. In the center of the group is a large truncated mound, between twenty and thirty feet in height. Another of like size occurs without the circle.—*Collins's Kentucky*, p. 176.

Edmonston County.—An enclosure on Indian Hill near Mammoth Cave.

ART. II.—*Notice of, and citations from a Voyage of Discovery and Research in the Southern and Antarctic Regions, during the years* 1839–43, by Captain Sir JAMES CLARK ROSS, R. N., Knt., D.C.L. Oxon., F.R.S., etc.; with plates, maps and woodcuts. In two volumes, 8vo, pp. 366 and 447. Lond. 1847.

(Continued from ii ser., vol. vii, p. 329.)

IN our last number we followed Captain Ross to his farthest Southern Point in January, 1841,—midsummer of the southern hemisphere. In the following pages we continue our abstracts for the remainder of his cruise.

In latitude 78° 15′ 3″ S., the barrier was 180 feet high, 1000 feet thick and stretched along for 450 miles; a beautiful sketch of a scene in this part of the Antarctic is given at page 232 of the first volume of Captain Ross's Journal. While cruising in these regions, they frequently threw overboard a bottle containing a notice of their proceedings from day to day and the position of the vessels.

Feb. 5.—Three large penguins were brought on board, one of which weighed sixty-six and the smallest fifty-seven pounds; their flesh is very dark and of a rank fishy flavor. Two seals were also captured to furnish oil.

Ice was taken on board to replenish the water—the ice of salt water being fresh.

Feb. 8.—An iceberg shewed a large rock upon it. Soundings were obtained seven miles from the barrier in lat. 77° 39′ in 275 fathoms; in one instance, within a quarter of a mile of the ice cliffs, the soundings were 330 fathoms with a green muddy bottom.

A view of the upper surface of the barrier was obtained on a narrow isthmus where the cliffs were about fifty feet high. The surface was quite smooth like an immense plain of frosted silver. Gigantic icicles hung from every point proving that it sometimes thaws, although in the month corresponding to the August of

England, the thermometer was at 12° and at noon only 14°. This cold was strongly contrasted with that of the northern seas, where in the corresponding season streams of water were constantly pouring from every iceberg.

Feb. 11.—Their escape from the ice barrier was critical. New ice rapidly formed; the pack closed in upon them and they were extricated only by a favorable conjuncture of the wind and great exertions in breaking the ice. They were hardly liberated before a violent gale came on with numerous icebergs all around; one of them was four miles long although not more than 150 feet out of the water, and doubtless a quarter of a mile beneath it. During the gale the decks and rigging of the ships and the clothes of the people were coated with ice.

Feb. 14.—The dip increased to 87°, showing that they were again approaching the magnetic pole now distant about 360 miles; the variation was 91°. The nearest approach to the magnetic pole had been about eighty leagues.

Feb. 16.—Being becalmed in the afternoon, they saw some magnificent eruptions of Mount Erebus. The lighted cinders were projected to a great height, but no flowing lava was seen as before, although the exhibitions were upon a much grander scale.

Feb. 17.—In latitude 76° 12′ S., long. 164° E., the variation was 109° 24′ E. and the dip 88° 40′. They were within 160 miles of the magnetic pole; but an impenetrable barrier of ice prevented a nearer approach. They deeply regretted the impossibility of wintering in those regions: could they have found a nook where the ships would have been safe, land parties could easily have reached the volcano and the magnetic pole. The position of the latter is however accurately known from calculation.

Feb. 19.—Mount Erebus was still in view—distant fifty leagues. The young ice formed rapidly around them presenting a continuous sheet, as far as vision extended; the ships could make little or no headway; but by rolling the boats before the ships' bow they succeeded in breaking it up. Along the barrier every bay was filled with packed ice so that the ships had no place in which to be secure; the cliffs were from 200 to 500 feet high and a chain of bergs ranged for miles in front of them as one outwork of frost.

Feb. 23.—Soundings in 180 fathoms brought up coral; the icebergs appeared to be all aground as none of them were less than 160 feet out of water.

Feb. 24.—An enormous glacier was distinctly traced descending as a continuous mass from near the tops of the mountains several miles into the sea, ending in stupendous cliffs in which a deep bay was formed having no passage except that by which the ships entered.

The variation diminished from 114° W. to 40° W., 74° in about 360 miles; the dip was now 86°.

Feb. 25.—A fine view of the coast was enjoyed in the afternoon. "The lofty range of mountains appeared projected with well defined outline upon a perfectly clear sky: although of a spotless white with but a patch of bare rock, yet the protuberances, cones and smaller eminences and deep valleys produced so much variety of light and shade as to relieve the monotonous glare of the surface.

The season was now so far advanced that great danger attended their lingering longer in these regions. The barrier of packed ice through which they had penetrated threatened to become a formidable obstacle to their escape, and moreover there was a heavy swell, which is characteristic of the south polar seas, rendering the navigation of the Antarctic at all times more hazardous than that of the Arctic ocean.

March 1 *and* 2.—*The aurora australis* appeared in bright colorless corruscations rising to 30° of altitude. This aurora differed from that seen in the arctic regions. The vertical beams were longer and the light came more in flashes; it was perfectly colorless and with a lateral flitting motion. The center of an irregular arch of light bore to the magnetic W., thus implying that as in the arctic regions, the principal seat of the aurora is not in the higher latitudes; in the southern hemisphere it is probably in lat. 68°.

March 7.—The perils of these Antarctic seas were numerous and appalling; but such dangers are of course encountered, more or less, by all navigators in polar regions. When in lat. 65° 31′ S., long. 162° 9′ E., a heavy easterly swell was driving them down upon the pack. From the mast-head, they counted at one time eighty-four large bergs and some hundreds of smaller dimensions.

"We found," says the narrator, "we were fast closing this chain of bergs so closely packed together that we could distinguish no opening through which the ships could pass, the waves breaking violently against them, dashing large masses of pack ice against the faces of the bergs; now lifting them nearly to their summit, then forcing them again far beneath their water line, and sometimes rending them into a multitude of brilliant fragments against their projecting points.

"Sublime and magnificent as such a scene must have appeared under different circumstances, to us it was awful if not appalling. For eight hours we had been drifting towards what to the human eye appeared inevitable destruction; the high waves and deep rolling of our ships rendered towing with the boats impossible, and our situation the more painful and embarrassing from our inability to make any effort to avoid the dreadful calamity that seemed to await us."—"In moments like these, comfort and peace of mind could be obtained only by casting our cares upon that almighty power which had already so often interposed to save us

when human skill was wholly unavailing. Convinced that he is under the protection and guidance of a merciful God, the Christian awaits the issue of events firm and undismayed, and with calm resignation prepares for whatever he may order. His serenity of mind surprises and strengthens but never forsakes him; and thus possessing his soul in peace, he can with the greater advantage watch every change of circumstance that may favor his escape."

"We were now within half a mile of the range of bergs. The roar of the surf, which extended each way as far as we could see, and the crashing of the ice, fell upon the ear with fearful distinctness, whilst the frequently averted eye as immediately returned to contemplate the awful destruction that threatened in one short hour to close the world and all its hopes and joys and sorrows upon us forever. In this our deep distress we called upon the Lord, and he heard our voices out of his temple, and our cry came before him." "A gentle air of wind filled our sails; hope again revived and the greatest activity prevailed to make the best use of the feeble breeze; as it gradually freshened our heavy ships began to feel its influence, slowly at first but more rapidly afterwards; and before dark we found ourselves far removed from every danger."

Position of the South Magnetic Pole.—Captain Ross concludes from all the observations that had been made, including those of the French and American navigators, that the South Magnetic Pole is in about 76° S. The theoretical views of Gauss had placed it in 66°.

The return to Van Diemens Land was not marked by any very extraordinary events. The line of no variation was crossed in lat. 62° 0′ and long. 135° 50′ E.

The *aurora* grew more frequent and more remarkable.

March 23.—A bright arch of the aurora australis of a yellow color and a purple hue extended across the zenith; a succession of lower arches was formed in the S.S.W., and the center of each arch gradually rose to the zenith before they disappeared. At the altitude of 45° they generally broke up into smaller streamers; this splendid display was as usual followed by a shower of snow.

March 25.—The aurora gave considerable light in the absence of the moon; it rose in arches of a yellow color with vivid flashes of a bright pink. The aurora appeared in concentric arches of diffused light, with an apparently rapid internal motion like a current passing through and lighting up a mist. At 10 o'clock a bright light appeared behind a dark cloud with pink and green colors; brilliant streamers darted to the zenith forming a corona with bright flashes of all the prismatic colors, green and

red being the most conspicuous. This aurora darted and quivered about the sky in every direction.

March 28.—Flocks of small dark colored petrel were seen on wing, which, judging by the time they occupied in passing, were from four to six miles in length and two or three broad.

March 30.—An equal temperature prevails in the ocean all around the earth between 50° and 60° S. lat., and they were now very near that mean as the soundings showed at various depths, even to 600 fathoms, the extremes being 38°·5 and 39°·8′.

The *auroras* appeared frequently and sometimes with great brilliancy.

April 2.—In a calm forenoon they sounded and found bottom in 1440 fathoms, 8640 feet, (almost 1¾ miles.) The latitude was 52° 10′ S., long. 136° 56′ E. The weight employed on this occasion was 336 lbs. The sun's heat was here felt in the ocean to the depth of 450 fathoms or more than half a mile. The specific gravity of the sea was the same below as at the surface, that is 1·0274.

April 6.—They arrived safely at Van Diemens Land and anchored off Rossback Observatory. The crews had enjoyed perfect health and they had not lost a man. Well might they respond with joy and gratitude to the warm congratulations of their friends, and especially of their distinguished patron, Sir John Franklin, the governor of the colony, who was the last to bid them adieu when they departed, and the first to meet them with a warm welcome on their happy return.

Here closes the first volume, we continue on with the second.

Van Diemens Land or Tasmania, 1841.—*April to July.*—*Magnetic Observations.*—The portable observatories of the ships were set up on shore and their instruments were carefully compared with those of the fixed observatory. The plan of observations was changed after the term day of February, in consequence of new instructions.

Fossil Trees are among the most interesting objects in this island. They are found in the Derwent valley, and are thus described by Count Strzelecki:*— "No where to my knowledge is the aspect of fossil wood more magnificent than in the Derwent valley, and no where is the original structure of the tree better preserved; while the outside presents a homogeneous and a hard glossy surface, variegated with colored stripes, like a barked pine, the interior, composed of distinct concentric layers, apparently compact and homogeneous, may be nevertheless separated into longitudinal fibres, which are susceptible of division into almost hair-like filaments."

* Physical Description of New South Wales and Van Diemens Land. London, 1845.

Dr. Hooker, of the expedition, speaks of the vast quantities of silicified wood, either loose on the plains, or imbedded in rocks, both igneous and aqueous;—the former being most remarkable from their singular beauty and the very perfect manner in which the structure of the woody tissue is retained. Many of the specimens perfectly resemble to the eye splintered white deal. The stump of the tree from which they came is a pine, about six feet high, 2½ in diameter at the base, and 15 inches at the top; it is silicified throughout; it stands erect, in a cliff of vesicular basalt, by which it was once enclosed. The exterior,—probably the bark, is beautifully agatized with a brown color and glossy lustre. The concentric annual rings, more than one hundred in number, are perfectly distinct, as well as the medullary rays, and the fibrous structure. The surface (the bark) is marked by those large circular disks which are characteristic of all the pine tribe.

Boulders of Basalt are numerous in the valley of the Derwent —they are cylindrical and flattened columns heaped together, with pebbles and spheroidal boulders of greenstone, piled up against an escarpment of the carboniferous series.

The basalt of Rose Garland contains fossilized trees, probably silicified previous to the irruption of the melted rock—while other trees not fossilized were consumed and have left moulds and impressions—as happened in Hawaii in 1840. In some instances these moulds have been filled by a second irruption, forming casts.

Coal mines and Sandstone quarries have been opened in this country. Copious citations are made in the narrative from Count Strzelecki's work which now lies before us, and to this we must refer for many interesting facts regarding the minerals of this country.

Tasmania abounds with good harbors; it has rivers of considerable magnitude; in many parts there is a rich soil and luxuriant vegetation, with splendid scenery and grand forests, some of the trees in which are 180 to 200 feet in height. It is capable of sustaining a large European population.

Marks to measure the ocean level compared with that of the land, were cut in a rocky cliff in the small island of Point Puer.

Captain Ross well observes, that if similar marks had been made during the early voyages of Bougainville and Cook, we should possess means of judging more perfectly than now, whether secular changes of level are general or local.

July 7.—The expedition again set sail for the Antarctic seas, after a warm adieu to the governor and other numerous friends. They passed port Arthur in Tasmania, one of the best harbors in Van Diemens Land, and steered for Port Jackson, New South Wales, where, without any remarkable event, they arrived, July 14. On their way up, (July 11,) they obtained soundings in

twenty-nine fathoms. They remained in the colony till August 5, and were much impressed by its prosperity, and by the opulence and extent of Sydney, the principal city.

Magnetic observations for comparison were instituted here by Captain Ross with satisfactory results.

In company with the governor (Sir George Gipps) he visited the Paramatta Observatory, fifteen miles up the river. It was established by the private munificence of Sir Thomas Brisbane, late governor of the colony. Signals by means of rockets were now arranged between this Observatory and Garden Island as a means of determining the longitude of these places, which was thus correctly ascertained.

Although this country is, not unfrequently, visited by severe drought, it experiences, occasionally, excessive falls of rain. During the twenty-one days that the expedition remained here it rained in all the days except four. On two or three occasions it came down in perfect sheets. On the afternoon of the 16th, during 2½ hours, more than three inches of rain fell; on the 17th, between 7 A. M. and noon, nearly five inches. The governor stated that, on one occasion, twenty-three inches fell in twenty-four hours, a quantity equivalent to what falls in a whole year in some parts of Great Britain. It created a temporary deluge with great destruction of property; indeed the soft sandstone which forms the foundation of the country is every where worn into deep channels by these occasional torrents.*

In New South Wales the country sometimes suffers very severely from want of rain, creating danger of a famine of both bread and water. The soil is extremely sandy and there are no springs and very few rivers. During the drought of 1838, a gentleman rode his horse forty miles without water, and eventually paid half a crown for less than a quart.

Governor Gipps, by damming up the water courses of winter, has obtained a sufficient supply.

August 5.—As they left the harbor, they found the temperature of the air 55° to 60° F., and that of the sea at 55°–63°. The ships were laden for three years even below their bearings, by provisions, stores and fuel, so that with a heavy press of sail they could not make over eight knots an hour. The Terror, being a heavy sailer, detained the Erebus in waiting for her to come up, and they had the mortification to see a merchant ship pass them under easy sail.

Aug. 8.—Falling stars were occasionally sought for, during the night, and as there was a deficiency of observers to watch

* At Joyeuse, in the department of Ardèche in France, there fell on the 9th of August, 1807, 9·87 inches of rain—then thought to be enormously great, but on the 9th of October, 1827, in twenty-four hours 31·17 descended at the same place.—*Arago.*

all parts of the heavens, some of the more intelligent and careful of the seamen were instructed for the duty, report being made every half hour to the officer of the watch. "One of the more zealous of these observers, who had not been so fortunate as to see any 'falling stars' during his first half hour, did not wish to leave his post when relieved, 'as he was sure two or three stars would fall in a few minutes; he had been watching them and could see they were shaking!'"

At noon, lat. 33° 40′ S., long. 64° 18′ E., temperature of the sea at 300 fathoms, 49°·7—at 150 fathoms 55°·8—at the surface 59°. The specific gravity was 1·0274 at 60°.

Aug. 9.—"*A bright meteor burst in the S. W.*, at the altitude of 20°, exhibiting a shower of beautifully variegated stars." On board the Terror it was observed to emerge from a dark cloud, near the Southern Cross, and in its descent it shewed fine bright lights. Fifteen falling stars were seen between 10 and 11 P. M.

Aug. 10.—*There were no soundings at* 820 *fathoms;* some new self-registering thermometers were tried, constructed to bear a greater pressure than any that had hitherto been encountered. It was ascertained that the mean temperature of the sea is here attained only below 800 fathoms.

Aug. 11.—*There were soundings in* 400 *fathoms;* the bottom was sand and small stones, and the dredge brought up beautiful corals, corallines, flustræ and crustacea. They were at this time about 300 miles N. of New Zealand.

The temperature of the sea-water at various depths was carefully observed in numerous instances. "In low latitudes, the surface water is hotter than that below; generally, the temperature sinks as the water shoals, or even *in passing over banks whose depth was very considerable;* the approach to land or shoal water is indicated by the thermometer, in many places with a high degree of sensibility."

New Zealand.—The first land that appeared in sight in New Zealand was "the high bold cape Maria Van Diemen, of romantic association." "It was so designated by Tasman nearly two hundred years ago, after a young lady of that name to whom he was attached and whom he afterwards married: she was the daughter or near relative of Anthony Van Diemen, the governor of the Dutch possessions in India, a great friend of Tasman, and by whom the expedition he commanded was sent forth." Tasman was therefore the discoverer of the north island of New Zealand, as well as of Van Diemens Land. The name of Tasmania now imposed on the latter island, is only a just tribute to the memory of the great navigator, and it has much the advantage in point of euphony.

August 17th, they arrived at the Bay of Islands. A place for observations was established at Paihia, the station of the Eng-

lish mission under Rev. Mr. Williams. The location was on a low beach very near a place called by the natives "Haumi," marked by a small cluster of trees, "where the bodies of the French navigator Marion and his companions were devoured by the savages." The French provoked this aggression by forcibly persisting to fish on ground which they were not aware was *tabooed* by the natives.

New Zealand having become an English colony, the natives are now only sojourners in their own country. We may refer to the narratives of Captains Fitzroy and Wilkes, and other published works, for a full description of the country and for a history of the English aggressions there. The missionaries have, in the mean time, persevered in their work of benevolence, and through all vicissitudes have maintained their sway over the native mind. To these topics we cannot do justice in so brief a summary, and shall therefore confine ourselves to a few notices on other subjects.

The mean temperature from August 19, to Sept. 17, was 53°·9, and the average 66° to 39°. In England, the mean temperature of March, the corresponding month, is 43·9, and the average range from 66° to 24°. The first month of spring in New Zealand has a temperature ten degrees higher than the corresponding month in England.

The mean temperature of the dew point was found to be 49°·6. The quantity of rain was 11·76 inches, and the greatest fall 5·5, which took place on September 9.

The mean height of the barometer is 30·034, and its range 1·14 inch. Diurnal variations of the barometer from 9 A. M. to 10 P. M., when it is greatest; also from 4 A. M. to 3 P. M., when it is least: difference ·041 inch. Mean temperature of the surface of the sea 56°.

For the next month, September 18 to October 18, the mean temperature was 57°·9, an increase of four degrees, while that of England increases 6°. Mean temperature of the dew point 53°. Greatest fall of rain October 17, was 2·84 in. Mean height of the barometer 30·118; range ·738 in. Greatest pressure, 9 A. M. and 10 P. M.; the least at 4 A. M. and 4 P. M.; difference ·044.

From October 19 to November 17, the mean temperature advanced 2½°, to 60°·5; range 74° to 47°. In England the mean temperature for May, the corresponding month, is 54°—range 70° to 33°. Mean temperature of the dew point 52°. Quantity of rain in New Zealand 9·5 in.; greatest fall, November 8, 2·1 in. In England, rain in May, 1·85 in. Barometer at the mean, 29·904, and wind N.; range of the barometer 1·80. Mean temperature for the year in England 49°·2, differing little from that of the three months of spring. Mean temperature in New Zealand very nearly 59°. According to Dieffenbach, the rain in the North Island is 34·49 in. Mean temperature of the whole year at Wellington

58°·2—that of the three spring months 57°·7. The coldest month is July, the hottest January.

At the Auckland Islands, about 100 miles south of New Zealand, Bay of Islands, the mean temperature is 59°, that of the three summer months 67°·2, that of the three winter months 52°.

They visited the missionary stations and the schools, and found every thing prosperous, and as they travelled the natives whom they met treated them with kindness. A large portion of this part of the island was covered with fern. On their way to the station of the Rev. Mr. Kemp, they met with a beautiful cataract; a broad sheet of water fell over basaltic columns seventy feet high into a deep circular basin. Forests of the Kauri pine were passed, and the Kauri resin was abundant in some places, buried in the soil, where it is supposed to have been derived from the former burning of the trees. This resin is largely exported. They ascended Puki Nui, a volcanic mountain 1240 feet above the sea, and in the vicinity of some small lakes they visited the hot sulphurous springs that rise here, with a temperature of 80° to 150°; they are elevated 648 feet above the sea.

The latitude of the Observatory was found to be 35° 17′ 46″·6 S., long. 174° 8′ 22″·7 E., and the mean magnetic dip from August 23 to October 25, 59° 33′ S. Highest tides 5 feet 10 inches to 6 feet 10 inches.

Departure from New Zealand.—On the 23d of November, 1841, they left New Zealand for Chatham Island, with a view to magnetic observations there, and also to judge of the capabilities for colonization and as a rendezvous for the whale fishery. For this latter purpose, the Auckland Islands are considered preferable, and are much frequented by the American whalers, being at a convenient distance from New Zealand and Australia, and possessing excellent harbors. November 24th they descried the East Cape, and during the 25th saw many sooty albatross, an elegant blue petrel, and the cape pigeon.

On crossing the 180th degree of longitude, they added a day to their week, making it *eight* days instead of the usual number *seven*. Having, by sailing to the eastward, gained twelve hours, it was necessary on entering west longitude to make their reckoning correspond with other places in west longitude; hence it was necessary to have two days following of the same date, so as by this means to lose the time they had gained and still were gaining in their eastward course. "We had therefore," Capt. Ross says, "two Thursdays and two twenty-fifth days of November in succession; so that after crossing the meridian and having made the alteration of a day, instead of being twelve hours in advance, we became this much in arrear of the time in England; this would gradually diminish as we pursued our easterly course, until on our return we should find them in exact accordance."

Nov. 27.—No bottom with 600 fathoms of line. At this depth the temperature of the sea was 44°·9; at 450 fathoms 46°·8; at 300 fathoms 49°·2; at 150 fathoms 53°·5; and at the surface 58°. Specific gravity of the surface water was 1·0274; at 150 fathoms 1·0272, and at 450 fathoms 1·0268. All these specific gravities were taken at the surface of the sea at the temperature of 60°. It was proved that the water beneath was specifically lighter than that at the surface when brought to the same temperature, as was confirmed by almost daily experiments.

Nov. 29.—A long-snouted porpoise was harpooned, and in its formidable jaws they found the teeth which the New Zealanders value so highly as ornaments, and whose source had been unknown.

Thick fogs prevented their landing on Chatham Island, and they kept in company with the Terror only by firing guns.

Dec. 3.—Barometer at the unusual height of 30·45. The cry of the penguins was heard, and the luminous patches in the sea were very brilliant.

Dec. 4.—Soundings were attempted with 1100 fathoms, but no bottom was found, and two new thermometers were lost; they had been attached to the line at intervals of 150 fathoms and the line broke. Another line being prepared, thermometers were sent down to 1050 fathoms and came up safe, having borne this enormous pressure, and recording the temperature at that deep region of the ocean to be exactly 40°, or thirteen degrees below that of the surface.

The mean temperature of the ocean is at least 900 fathoms, or more than a mile below the surface, in lat. 49° 17′ S., and long. 172° 28′ W.

The penguins were now going to the eastward, proceeding to their breeding quarters—perhaps in the Nimrod Islands. "It is a wonderful instinct far beyond the powers of untutored reason, that enables these creatures to find their way, chiefly under water, several hundred miles, to their places of usual resort, as each succeeding spring season of the year arrives."

Dec. 9.—Lat. 52° 32′ S., long 161° 20′ W., the dip had increased to 70° S.; the variation was 15° 10′ E. A breeze became a gale, with rain and snow, and the thermometer sunk from 42° to 34°; the barometer falling to 29·1 at midnight.

It was a severe night, but not expecting ice in so low a latitude they pushed on before the gale in a thick snow storm. They had been drifted by a current fifteen miles daily to the east, and it was concluded that a current circulates round the globe in a belt of about fifty degrees on each side of the fiftieth degree of latitude.

Dec. 13.—The circle of uniform temperature of the ocean was crossed in lat. 55° 18′ S., long. 149° 20′ W. At 600 fath-

oms the temperature was 39°·7, and at the surface 39°. At profound depths of several thousand fathoms the temperature would doubtless be uniform or nearly so.

In a very dark and foggy night the ships kept company by firing muskets, but the bell and gong were still more audible, and a conversation was carried on with the other ship by a speaking trumpet with almost perfect distinctness.

Dec. 15.—The barometer rose, and although the fog was so thick that the vessels were invisible to each other, still the orders were distinctly given and understood.

Dec. 16.—The fog having cleared a little, several icebergs were seen—temperature of the sea below 33°. The largest berg was 130 feet high and three quarters of a mile in circuit; it was table topped, deep caverns had been worn in its sides, and a long line of loose pieces extended several miles to leeward of it, and other masses were ready to fall.

The latitude was 58° 36′ S., long. 146° 43′ W., magnetic dip 73° 23′ S., variation 14° 40′ E.

On this meridian it was determined to penetrate due south in the hope of discovering land, (which was indicated by the appearance of the ice,) and by a wish to deviate as far as possible from the route of last year.

Dec. 17.—Icebergs and their floating fragments were frequent. The proximity of a large body of ice was indicated by the ice blink and by a sudden fall in temperature to 29° at midnight, and at 3 A. M. the main pack was seen stretching across the course from E. to W.

They ran into it at once, and it being light and open, they made thirty miles south without much difficulty, but as it then became heavy and more closely packed they could not continue to sail exactly on a meridian. Temperature 28°, lat. 60° 50′ S., long. 147° 25′ W. Dip 76 S., variation nearly 19 E.

Myriads of animalcules stained the ice as had been seen in the former cruise off Mount Erebus; they were ascertained at Berlin by Ehrenberg to be creatures with siliceous shells.

Whales were seen among the ice, and so tame that the ship ran upon one and received a shock.

Dec. 19.—The ice was very close, and the vessels forced their way from hole to hole; they had penetrated nearly 100 miles in a S.W. course, and the ice giving way a little the ships were pushed twenty miles further; but on the 20th, the ice again closed and stopped their progress. Soundings were obtained in 1700 fathoms, almost two miles: the mean temperature in this latitude is about 600 fathoms below the surface.

Some seals were killed on the ice; they seemed unconscious of danger and made no resistance. In the stomach of one were nine pounds of granite stones, doubtless from the icebergs, as

there was no land above water within 100 miles. In others were found fish and shrimps, their proper food.

Dec. 25.—Christmas day was passed in close packed ice, near a chain of eleven bergs and in a thick fog; but the people were still cheered by Christmas fare reserved for the occasion.

Dec. 26–30.—Becalmed in a sea-lake surrounded by ice; there appeared no chance of escape, and therefore mooring the ships to the ice the crews were employed in filling the water tanks with ice.

Dec. 31.—The year closed gloomily in this icy prison; the ice was much broken and heaped and no piece was on a level, thus proving the enormous pressure to which it was subjected. No piece was seen over a quarter of a mile across, whereas in the Arctic regions, floes and fields of several miles in diameter are common, and sometimes from the mast-head the boundary cannot be discovered. The difference is occasioned by the comparative quiet of the northern, and the turbulence of the southern polar seas.

Jan. 1, 1842.—No outlet was visible from the mast head; they had advanced 250 miles into the pack, and were in lat. 66° 32′ S., long. 156° 28′ W. They had crossed the Antarctic circle this season on the same day as the last, and were now 1400 miles east of the meridian on which they passed it at that time.

Warm clothing was distributed, and new year's day was spent in customary hilarity and festivity. Temperature of the sea at the surface 28°, at 1050 fathoms 39°·6.

Gales succeeded, and drifted the pack with the ships to the north, but they found occasionally some clear water and managed to regain a part of the space they had lost, but it was a severe service in the midst of thick snow storms, and with vessels and rigging encumbered with ice.

Jan. 11.—The great penguins were numerous, and several were brought on board alive, but it was a difficult and cruel operation to kill them, until they resorted to hydrocyanic (prussic) acid, a teaspoonful of which destroyed life in less than one minute. The largest weighed seventy-eight pounds. They are stupid birds and allow themselves to be knocked on the head with a bludgeon. Their food consists of crabs and other crustacea, and in the stomach was frequently found ten pounds weight of pebbles, granite, quartz and trap. When alarmed they skated along over the snow faster than the people could follow them; lying down on the belly they impel themselves by their powerful feet, using their short wings to steady them laterally.

The largest seals that were captured measured twelve feet long by six in circumference—weighed 850 pounds and yielded more than sixteen gallons of oil. In the stomach of one they found twenty-eight pounds of fish. The largest seals have teeth as

formidable as those of the polar bear and capable of inflicting dangerous wounds. The males of the middle sized species wound each other severely in their combats.

A small ferocious looking fish inhabits these high latitudes—only 6½ inches long and weighing 2½ ounces; they are preyed upon by the seals and petrels and they in turn devour the smaller crabs and Limacinæ. In a region where there is no vegetation a chain of animal existences is sustained by each preying upon that below it, and ultimately the infusorial animalcules afford a pabulum* which forms the last link in the chain.

Jan. 19.—They contended for several days with the ice, availing themselves of every opening; when moored to the ice floes their eight inch cables were snapped like cords, for the wind had risen to a heavy gale. Soon after midnight they found it impossible, any longer, to hold on to the floe, and therefore took shelter under a berg, nearly a mile in diameter, dodging about in the mean time in search of an opening. The sea rose to a fearful height breaking over the loftiest bergs; the ships were entangled in an ocean of rolling fragments of ice hard as granite, and which were dashed against them with so much violence that the masts quivered to their fall, which was instantly expected. Both ships having carried away their rudders their condition seemed desperate; hour after hour passed without relief, and it seemed almost impossible that the ships should any longer sustain the shocks which were every moment received. The loud crashing noise of the straining and working of the timbers and decks was sufficient to appall the stoutest heart, but during the twenty-eight hours of this fearful struggle all did their duty with composure and firmness. The storm was at its height at 2 P. M. when the barometer stood at 28·40 inches; after that time it began to rise. But the swell had not subsided; the ships still rolled and groaned amidst the ruins of crashing icebergs, over which the ocean poured its mountainous waves, throwing large masses upon one another, and then submerging them again, dashing and grinding them together with fearful violence. The awful grandeur of the scene can neither be imagined nor described; the people watched with breathless anxiety the effect of each collision and the vibration of the tottering masts whose fall it would have been impossible to prevent. The ships were so near to each other that they mounted the ridges of two contiguous waves, while the deep chasm between was filled with rolling masses of ice; and as the ships descended into the hollow between the billows, the main topsail yard of each could be seen from the deck of the other just level with the crest of the intervening wave.

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* These, however, must ultimately derive their support from vegetable infused matter brought, it may be, from other climes.—*Ed.*

Jan. 21.—The storm abated in violence. They found they had made progress. The sea was more open but they judged it best to force the ships into the thickest of the pack, where they moored them to a large cake of ice which lay between the ships and the pack which was now comparatively quiet. By great exertions the damages were repaired in the course of three or four days; new rudders were shipped,—the hulls of the vessels were found to be nearly tight and had sustained no vital injury, and thus after five weeks of the most precious part of the season were lost by their detention in the ice, they were now in a condition to prosecute their enterprise in the brief period of summer that remained.

The next month, January 26 to February 28, was passed in arduous efforts, and severe conflicts were experienced of the same general character as those of which an abstract has been given.

Feb. 1.—Lat. 67° 18′ S., long. 158° 12′ W., the clear sea came into view; and the margin of the pack, seen through the deepening shades of night, presented a fearful line of breakers, but they felt compelled to pass through at all risks.

Feb. 4.—They were in lat. 68° 50′ S., long. 160° 20′; the dip was 81° 37′ and the variation 29° 41′ E. The Terror was on fire for two hours near the kelson, but a deluge of water poured from a powerful engine, making it two feet deep in the hold, extinguished the fire without giving the alarm to the other ship.

Feb. 8.—They passed a berg of four miles in diameter, believed to be the same they saw last year, February 13, in lat. 76° 11′ S., long. 172° 7′ W.; that seen to-day was in 70° 30′ S., long. 173° 10′ W.

Feb. 21.—A small fish was found in the ice, frozen upon the bow of the Terror supposed to have been suddenly caught by the freezing of the water.

Feb. 22.—In lat. 76° 42′ S., a piece of ice was seen bearing a black rock apparently six feet in diameter, and the next day numerous stones and patches of soil were observed upon the bergs indicating the proximity of land.

The barrier of ice was seen rising 107 feet above the sea; it was probably attached to the continent in lat. 78° 11′ S., long. 161° 7′ W. This, the extreme southern latitude attained, was six miles south of that which had been reached last year.

Mountains of great height with an undulating surface entirely covered with snow were seen from the mast head; such at least was the appearance, but the conclusion was adopted with some caution.

Feb. 24.—The young ice formed so fast as to present an unbroken sheet from the mast head, and a very short delay might fix the ships and detain them through a south polar winter; with a favoring breeze they therefore pushed on with all sail set, and after breaking through thirty miles of ice they were once more in clear water.

Feb. 28.—The ships were in lat. 70° 54′ S. and long 175° 36′, and the crew were in perfect health notwithstanding the severity of the service which they had performed.

March 1, 1842.—The attempt to reach a higher southern latitude being relinquished, the vessels sailed for the Falkland Islands.

In lat. 69° 52′ S., long. 180°, they passed a chain of the most magnificent bergs they had yet seen; they were of a blue color and much worn by the action of the sea. Some hundreds of seals were plunging and splashing about, and two or three on a point of ice maintained their position with much difficulty as the waves broke over them.

The sea had assumed its oceanic blue color, free from the ferruginous tinge of the animalcules which give a dirty brown tint to the waters of the southern ocean, whose frigid temperature they appear to prefer.

March 5.—They passed the Antarctic circle after being sixty-four days to the south of it, and two days later, several pieces of sea weed gave them the first returning notice of the vegetable kingdom in lat. 64° S.

On the 16th of April the ships dropped anchor in St. Louis, the principal port of the Falkland Islands.

The three succeeding chapters of this work, covering eighty pages, are engrossed by the Falklands and by Cape Horn, Fuegia and its inhabitants, and by other topics which have been so fully reported in the narratives of the Adventure and Beagle, and of the American Exploring Expedition, that we pass them by with only a few notices. The wild cattle of the Falklands and their important relation to the supply of ships, give a principal interest to this group of cold and stormy islands. The hunting of these powerful, courageous and savage animals, is a highly exciting and dangerous employment carried on principally by the Gauchoes or original natives of the islands.

The provision of nature for the support of the cattle is remarkable, especially in the tussock grass of which Dr. Hooker the botanist of the expedition has given a very interesting account. The tussock grass contains a sweet edible core which will sustain human life.

These islands are rich in certain families of plants. The lichens are very abundant and conspicuous. Sea weeds abound on the rocky coast. An enormous mass of marine vegetation is cast upon the shores, chiefly the *Macrocystis pyrifera*, *Lessoniæ*, and *D'Urvillæa utilis*. Wrenched from the rocks and twisted together by the rolling surf, they form enormous vegetable cables much thicker than the human body and several hundred feet in length. The *Lessonia* is like a small tree eight or ten feet high; the stem is as large as a man's thigh, the leaves are two or three feet long and three inches broad, and when in the water they

hang down like the boughs of a willow. In many places the plant is so abundant as to form a submersed forest, presenting, when seen from a boat, through the clear water, a mass of green foliage.

It is the residence of a vast exuberance of animal life,—worms, sponges, corals, crabs and other crustacea, flustræ, eggs of fishes and mollusca, serpulæ, &c. Some of the large sea weeds of the Fuegian shores are rich in manna and iodine, as ascertained by Dr. R. D. Thomson.

Cape Horn always disappoints the voyager, in his first sight of it. It is only part of a small island and being only 500 to 600 feet high it has no grandeur; yet it becomes invested with terror when it is lashed by the stormy billows of an Antarctic winter.

Third Voyage to the Antarctic regions.—This voyage was less remarkable than either of the two former, and without following it in much detail, we present only a few of the more interesting results.

Dec. 17, 1842.—The expedition left Port Louis intending to penetrate by the meridian of 55° W., or in case of insuperable obstructions by that in which Weddell reached the latitude of 74° 15′ S., three degrees farther south than any preceding navigator. On December 24th, they saw the first iceberg in lat. 61° S.

Dec. 25.—Although surrounded by a multitude of icebergs, they kept a merry Christmas with roast beef from the oxen of the Falklands, presented by Governor Moody for the occasion.

Dec. 27—Frequent loud reports were heard from the crashing icebergs as they broke up and rolled over, making it dangerous to approach them. On the 28th, land was seen, supposed to be the "Point des Français" of Admiral D'Urville. An enormous glacier several miles in breadth descended from an elevation of 1200 feet into the ocean, presenting a vertical cliff 100 feet high.

They bore away to the south, along a coast line of icy cliffs in a sea thickly studded with grounded bergs. The 29th, they saw a great number of the largest sized black whales, so tame that they would hardly move to get out of the way of the ships; any quantity of oil might have been obtained in a short time. A few days after they saw them lying upon the surface of the water in all directions, and were astonished by their enormous breadth.

Dec. 30.—Lat. 63° 36′ S., long. 54° 33′ W. Land to the S. and S.W. entirely covered with snow, except in a few places where vertical cliffs broke through the mountain glacier; elevation of the highest peak 3700 feet.

Jan. 1, 1843.—In lat. 64° 14′ S., long. 55° 54′ W. A new mountain 7050 feet high was named Haddington. At evening being be-

leaguered with icebergs they made fast to a floe two or three miles in diameter, and had a berg of four or five miles diameter and 150 feet high for a dangerous companion through the whole day.

Magnetic observations were made upon the ice; the results were entirely satisfactory; the magnetic dip was 63° 17′ S., and the variation 20° 53′ E. Soundings in 152 fathoms, bottom blue mud.

Jan. 6.—The two commanders went on shore on an island and took formal possession of it and of the neighboring land; it was of volcanic formation and here the last vestiges of vegetation are found, not rising on the mountains above 1400 feet of elevation.

Penguins and cormorants are found in these stormy islands lying immediately south of Cape Horn, and in their precipitous cliffs the petrels build their nests.

Jan. 24.—Unavailing struggles with packs of ice prevented the ships from penetrating farther south at this time than 64° 24′ S., in long. 55° 11′ W.; magnetic dip 63° 4′.

Feb. 4.—They got clear of the pack in lat. 64°, long. 54°. On February 6, seals were numerous and they killed one that measured twelve feet four inches long and weighed 1145 lbs. On the 22d, they crossed the line of no variation in lat. 61° 30′ S., long. 22° 30′ W., magnetic dip 57° 40′; they concluded that the position of the magnetic pole was on a meridian half way between this and New Zealand and that there is only one pole in the southern hemisphere.

Feb. 27.—In a snow storm so thick that the ships could not be seen, a diffused auroral light gave considerable assistance.

March 1.—They passed the Antarctic circle three days earlier than in former seasons. On the 2d, a splendid morning of sunshine after six weeks of cloudy weather, gave opportunity for experiments on the heating power of the sun's rays in these latitudes.

March 3.—No soundings with 4000 fathoms of line—more than four miles. March 5, lat. 71° 30′ S., long. 14° 51′ W., the highest which they attained this cruise; a cask was thrown overboard containing a paper stating the fact with the attestations of the officers.

March 10.—They saw the tail of the great comet which was seen a few days sooner at the Cape of Good Hope, St. Helena and Barbadoes. In the morning they recrossed the Antarctic circle in long. 13° 30′ W. On the 20th at noon they crossed the meridian of Greenwich in lat. 54° 7′ S., and still icebergs were visible causing false outcries of land.

Circle of mean temperature of the sea.—In their various wanderings they crossed this circle on seven different occasions in the extreme latitudes 52° and 57° 52′ S., and in five inter-

mediate latitudes, giving a mean latitude of 56° 14′. "It is evident therefore that about this parallel of latitude there is a belt or circle round the earth, where the mean temperature of the sea obtains throughout its entire depth, forming a boundary or kind of neutral ground between the two great thermic basins of the ocean. To the north of this circle, the sea has become warmer than its mean temperature, by reason of the sun's heat which it has absorbed, elevating its temperature at various depths in different latitudes. So that the line of mean temperature of 39°·5, in lat. 45° S., has descended to the depth of 600 fathoms; and at the equatorial and tropical regions, this mark of the limit of the sun's influence is found at the depth of about 1200 fathoms; beneath which the ocean maintains its unvarying temperature of 39°·5, whilst that of the surface is 78°." "So likewise to the south of the circle of mean temperature, we find that in the absence of an equal solar supply, the radiation of the heat of the ocean into space occasions the sea to be of a colder temperature as we advance to the south; and near the 70th degree of latitude, we find the line of mean temperature has descended to the depth of 750 fathoms, beneath which again, to the greatest depths, the temperature of 39°·5 obtains whilst that of the surface is 30°."

"This circle of mean temperature of the southern ocean is a standard point in nature, which, if determined with very great accuracy, would afford to philosophers of future ages the means of ascertaining if the globe we inhabit, shall have undergone any change of temperature, and to what amount during the interval."

"These observations force upon us the conclusion that the internal heat of the earth exercises no influence upon the temperature of the ocean, or we should not find any part in which it was equable from the surface to the great depth we have reached; a new and important fact in the physics of our globe."

April 4.—*They arrived at the Cape of Good Hope*, returning for the third time from the Antarctic circle "without a single individual of either of the ships upon the sick list."

April 30.—*They left the Cape*, touching at St. Helena and the Island of Ascension, and at all these places as well as at Rio Janeiro, the magnetic experiments were repeated to their satisfaction. On the 3d of June, in lat. 15° 3′ S., long. 23° 14′ W., they failed to obtain soundings at the depth of 4600 fathoms, or 5¼ miles, the greatest depth of water in the ocean that had been actually ascertained; but it is not improbable that there are depths still more profound.

July 3.—*They crossed the line of no dip*, in lat. 13° 20′ S., long. 28° 11′ W., and of course were on the magnetic equator. Their "barometrical experiments had proved that the atmospheric pressure is considerably less at the equator than near the tropics, and south of the tropic of Capricorn, where it is the greatest, a gradual

diminution occurs as the latitude is increased." The mean elevation of the barometer in the Antarctic latitudes is about an inch greater than in other parts of the world. "It had been considered that the mean pressure of the atmosphere at the sea level was nearly the same in all parts of the world, as no material difference exists between the equator and the highest parts of the world."

Sept. 2.—They descried the shores of Old England; the ships anchored off Folkstone, and in the morning the commander of the expedition hastened to London to make his report to the Admiralty.—B. S., Sr.

ART. III.—*On Ancient Sea Margins;* by R. CHAMBERS, Esq., (from a letter to one of the Editors, dated Edinburgh, April 10, 1849.)

I HAVE read with much interest, Mr. Dana's remarks on my 'Ancient Sea Margins,' inserted in your Journal for January, and reprinted in this month's number of Jameson's Edinburgh New Philosophical Journal. These remarks do not the less please me, that they are mainly an expression of the doubts and difficulties which the announcement of the subject is apt to raise in an ingenious and enlightened mind. I should be most happy if by a few observations in reply I could in any degree remove, or even soften those doubts: for their complete removal I believe I must be content to wait till one or two candid enquirers shall take the trouble to go over the ground which I have traversed.

Mr. Dana is perfectly right in his descriptions of river-side terraces, and in all his speculations as to their cause. They are undoubtedly the relics of sheets of alluvial matter which originally filled the bottoms of the valleys where they occur. They mark a former height at which the river had run, and the reason of the river having cut down the original alluvial sheet so as to leave only these terraces high above its present waters is undoubtedly the withdrawal of a body of water, which formerly received the river, to a lower level. The matter is very much overlooked in my volume, because few examples of such terraces had come under my attention in Scotland; but it is amply treated in a paper which I read in December last before the Royal Society of Edinburgh, and which has been since printed in Jameson's Journal.

It is unfortunate that the 'Ancient Sea Margins' should have contained so little on this subject, since, had the case been otherwise, Mr. Dana's doubts might have been much extenuated, and he might have left the American geologists in a more hopeful frame of mind as to the line of investigation which I have hum-

bly ventured to point out. He may be assured that there is in my book no such extensive mistake as he is apprehensive of. The terraces and other markings there described are (overlooking a few peculiar cases where an explanation has been supplied) all of them, as far as the fidelity of my observations may be depended upon, strictly level. They are distinguished from ancient river alluvia, not merely by this powerful feature, but still more decidedly by local situation, their whole form and character, being manifestly not the remains of sheets of water which originally spread across the whole of certain valleys at the lowest and narrowest point, but the remains of benches of alluvium (if I may so express myself) left in greater or less extent along the side of wide valleys, altogether out of the range of any fluviatile operations (except in the special case of the deltas of side rivulets, which I am here leaving out of view.) In Scotland, the sea line of which is so irregular, a terrace is seen on a line of coast towards the ocean—it turns round and passes also along the country fronting towards a frith :—pass beyond the head of the frith, and you still find the terrace, always level, and always at the same level, where found at all. Let this kind of observation be repeated many times, and what can be concluded but that the part of the valley now far removed from salt water, was once the bed of an estuary prolonged much beyond its present limits? We may ascend the valley till it becomes narrow enough to have river terraces also; but these are of a strikingly different character, much more palpable, of declining surface, always near to the river both in horizontal and vertical space—in short, not to be mistaken for the other class of objects by any but a very unprepared observer. Standing, therefore, on the facts which I have amassed, I deny Mr. Dana's conclusion, that 'the terraces in the higher portions of a country are not satisfactory evidences of as many distinct elevations, nor of the actual height of any elevations the country may have experienced'—and that 'the terraces towards the sea are more trustworthy.' There is positively no distinction between them, beyond the simple fact that the sea may still be visible from one position and not from the other.

Mr. Dana's doubts lead him to call for observations of a more searching and exact nature than he supposes to have yet been made, and he lays down certain tests which he deems essential in the investigation. Being conscious of having done only what may reasonably be expected of one individual to open up the enquiry, I desire nothing so much as to see others, both in this country and elsewhere, engage in the same pursuit; but I demur to some of the tests, and a few of the particulars for examination instituted by Mr. Dana, I deem unnecessary. I confine myself, however, to a denial of Mr. Dana's proposition, that 'the marine origin of a bed [understanding this term to include terraces] is

to be proved [that is, I presume, only] by its resemblance to marine formations and its containing marine relics,'—as far as the latter term is concerned. The terraces which I have spoken of as ancient sea margins do, in many instances, present such an arrangement of water-worn materials as might be expected on a coast. In many cases, there is no decisive feature of this kind, or I have not been able to ascertain particulars. On this point I am hopeful of seeing much new light as the investigation proceeds, particularly if I may believe that M. Morlot, of Vienna, is not deceived in thinking, as he informs me, that he can distinguish sea from river pebbles. With regard, however, to marine relics, I think the importance which Mr. Dana attaches to them is unduly exclusive. It might even be that they would prove a fallacious guide in the present enquiry, as indicating only the general fact of a former presence of the sea (for which indication they are in a manner superfluous), and not the special fact that the spot where they were found was a *margin* of the sea. In the climate of Scotland, it is quite hopeless that shells should be preserved in a porous bed for a great length of time, and I am not therefore surprised that no such relics are found in any but comparatively recent sea margins. But if we find other proofs, as in the form of the ground recalling exactly the forms of existing beaches, the character and arrangement of inorganic materials, and identity of levels over a wide area, (a kind of proof the most rigid of all, being mathematical,) are we to hold them as nought merely because we lack a kind of proof which is not reasonably to be expected in the case? Against such reasoning I must enter my humble, but energetic protest. And I believe that Mr. Dana, on going into a practical investigation, would very quickly justify me in doing so.

Let me conclude with the expression of a hope that some of the American geologists will ere long go into the enquiry with more or less regard to the rules laid down by Mr. Dana.

ART. IV.—*On the Diurnal Variations in the Declination of the Magnetic Needle, and in the Intensities of the Horizontal and Vertical Magnetic Forces;* by WILLIAM A. NORTON, Professor of Mathematics and Natural Philosophy in Delaware College.

IN a memoir published in vol. iv of this Journal,* I gave an exposition of a new theory of Terrestrial Magnetism, of which the following are the fundamental principles: 1. Every particle

* Pages 1 to 12 and 207 to 230.

of matter at the earth's surface, and to a certain depth below the surface, is the centre of a magnetic force exerted tangentially to the circumference of every vertical circle that may be conceived to be traced around it. 2. The direction of this force is different, according as it solicits the north or south end of the needle; and it is always such, that to the north of the acting particle the tendency is to urge the north end of the needle downward and the south end upward, and that to the south of the same particle it is to urge the north end upward and the south end downward. 3. The intensity of the magnetic force of a particle of the earth, at a given distance, is approximately proportional to its temperature, or amount of sensible heat; and at increasing distances, diminishes according to some unknown law. I was conducted to these principles by the theory which I had been led to adopt concerning the physical nature of the Imponderables: which is, that all the phenomena of the imponderables are but different effects of different vibratory motions of the particles of matter, and of the ethereal undulations produced by these vibrations. I accordingly conceived each particle of the earth's mass to be the centre of a system of undulatory movements propagated through the surrounding ether, and of every variety of time and intensity of vibration within certain limits—waves of light, heat, and magnetism. The vibrations of the ethereal particles, in a wave of magnetism, I supposed to be in the surface of the wave, or transversal to the line of propagation of the wave, as is known to be the case with a wave of light, and I regard the magnetic forces as probably due to these transversal vibrations. I was thus led to consider the sun as the probable source, at the same time, of waves of heat, light, and magnetism, and that the molecular forces of vibration due to the different kinds of waves would probably vary according to the same law, or approximately so, in passing from one point to another on the earth's surface, and accordingly that the temperature of a particle might be taken as a measure of its magnetic force. Although I was thus conducted, by these physical speculations, to the fundamental principles of what may be characterized as the Thermal Theory of Terrestrial Magnetism, these principles may nevertheless have no real connection with the physical theory in which they originated. The tangential magnetic forces which I suppose, may be due to electric currents or may be fundamental properties of matter. The investigations of this and the previous memoir, conclusively establish the fact of the existence of these forces, and of their supposed connection with the thermal state of the earth, but are in no way essentially dependent upon any physical speculations concerning their origin. These form a debatable ground beyond the thermal theory which I have undertaken to develop and follow out into some of its consequences, about which I do not at present concern myself.

From the fundamental principles which I have stated, I deduced, in the memoir referred to, three simple formulæ; one, for the horizontal component of the directive force of the needle, or the horizontal magnetic intensity of the place; a second, for the vertical intensity; and a third, making known the declination. These formulæ were afterwards tested by numerous comparisons with the results of observations made in every variety of locality in the northern hemisphere of the earth. The agreement was found to be very close—the differences amounting only to a few hundredths for the horizontal and vertical forces, and less than 2° 40′, and in most cases less than 1° for the declination. The positions of the magnetic poles, the pole of maximum intensity, and the magnetic equator were also theoretically deduced, and shown to correspond very closely with their observed positions. In view of the whole discussion the following great truths were supposed to have been established.

1. All the magnetic elements of any place on the earth may be deduced from the thermal elements of the same; and all the great features of the distribution of the earth's magnetism may be theoretically derived from certain prominent features in the distribution of its heat.

2. Of the magnetic elements, the horizontal intensity is nearly proportional to the mean temperature, as measured by a Fahrenheit's thermometer; the vertical intensity is nearly proportional to the difference between the mean temperatures at two points situated at equal distances north and south of the place, in a direction perpendicular to the isogeothermal line (that is, a line conceived to be traced through all points at which the mean temperature of the matter of the earth, near its surface, is the same as at the station of the needle): and, in general, the direction of the needle is nearly at right angles to the isogeothermal line, while the precise course of the inflected line to which it is perpendicular may be deduced from Brewster's formula for the temperature, by differentiating and putting the differential equal to zero.

3. As a consequence, the laws of the terrestrial distribution of the physical principles of magnetism and heat must be the same, or nearly the same; and these principles themselves must be physically connected in the most intimate manner.

4. The principle of Terrestrial Magnetism, in so far as the phenomena of the magnetic needle are concerned, must be confined to the earth's surface, or to a comparatively thin stratum of the mass of the earth.

5. The mechanical theory of terrestrial magnetism which has been under discussion, must be true in all its essential features.

6. We may derive the magnetic elements by very simple formulæ, and with an accuracy equal to that of Gauss's formulæ,

from a very small number of magnetic data determined by observation, and the mean annual temperature of the place.

From the theoretical investigation of the normal state of the terrestrial magnetic elements, I propose, in the present article, to proceed to the discussion in the light of the same theory, of their Diurnal Variations. This theory furnishes us the following general principles as a basis for this discussion. 1. The horizontal magnetic intensity of a place is proportional to its temperature. 2. The vertical intensity is proportional to the difference between the temperatures of two places situated at equal distances north and south of the isogeothermal line, in a direction perpendicular to it. 3. The direction of the needle is nearly perpendicular to the isogeothermal line. From these general principles we may draw the general conclusions, that the variations of the horizontal and vertical magnetic intensities must be linked to the variations of the temperature of the station of the needle and of the differences of temperature of places north and south of this, and that the variations of declination must be connected with the variations in the position of the ideal line passing through all places which have the same actual temperature as the given place; which line may be called the *true* isogeothermal line. If the latter conclusion be true, it may be added that the variations of declination must also be connected with the variations in the differences of temperature of places situated to the East and West of the station of the needle.

The data for the detailed discussion have been chiefly taken from the Report of the "Observations at the Magnetic and Meteorological Observatory at the Girard College, Philadelphia, made under the direction of A. D. Bache, LL.D., 1840 to 1845," and the Report of the "Magnetical and Meteorological Observations, made at Washington by Lieutenant J. M. Gilliss, U.S.N., dated August 13th, 1838." The first Report contains a complete series of Magnetic and Meteorological Observations, generally either bi-hourly or from hour to hour, extending from June, 1840, to June, 1845, besides Term Day Magnetic Observations, and Extraordinary Observations. Tables of the daily, monthly, quarterly, semi-annual, and annual means, and of the hourly or bi-hourly means for months, are given; and curves traced exhibiting these results to the eye, and showing the Extraordinary and Term Day Observations. The second Report comprises a Journal of Meteorological Observations made at four different hours during the day, (3 A. M., 9 A. M., 3 P. M., 9 P. M.,) kept from July, 1838, to June, 1842; a set of bi-hourly meteorological observations and observations of declination extending from June, 1840, to July, 1842; Term Day and Extraordinary Observations; and occasional observations of the dip of the needle. Tables of abstracts are also given, and curves showing the variations of declination and temperature on the term days.

Diurnal Variations of the Horizontal Magnetic Intensity.

The formula which the Thermal Theory of Magnetism has furnished for the horizontal magnetic intensity of a place is

$$H = C' T$$

in which C' is a constant, and T the mean annual temperature of the place. This formula is equivalent to the statement that the mean horizontal magnetic force is proportional to the mean temperature. We have therefore to compare the diurnal variations of the horizontal force with the diurnal variations of the temperature of the place. The theory strictly requires that the comparison should be with the daily variations in the absolute amount of sensible heat near the earth's surface, but we know, from the laws of the heating and cooling of bodies, that when the temperature is rising at its surface the earth is, in general, receiving more heat than it loses, and that when the temperature at the surface is falling, it is losing more heat than it receives—so that a rise or fall of surface temperature will in general indicate an increase or decrease of the total amount of heat. This consideration suffices for the enquiry which first arises, viz.: whether the horizontal force increases and decreases with the total amount of heat. A good set of observations of the daily variations of the temperature below the surface would be required for a thorough and minute discussion of the subject before us, but the facts already known and the established theory of the heating and cooling of bodies appear to supersede the necessity of such observations, except when the attempt is to be made to obtain precise quantitative determinations.

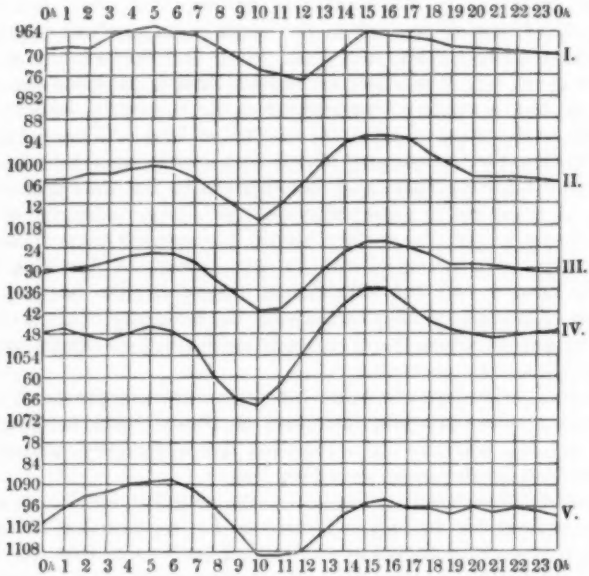
We will begin by comparing the curve showing the mean daily variation of the horizontal intensity at Philadelphia for the year 1844 (fig. 3), with the curve showing the mean daily variation of temperature for the same year (fig. 8).

It will be observed that the horizontal intensity attains its maximum at from 15^h to 16^h, or from 3 to 4 P. M., and that the maximum temperature occurs at the same hour;—also that the horizontal intensity increases with the temperature in the forenoon (after 10^h), and decreases with it in the afternoon and evening. The same correspondences are observable in the curves for the other years and for the quarters of years, with the single qualification, that the maximum of horizontal intensity sometimes occurs an hour or two later than the maximum of temperature. They are an indication that the daily variation of temperature is, in all probability, at least one cause of the variation of horizontal intensity. When we compare the curves still farther we notice the following points of difference between them. 1. The horizontal force increases during the latter half of the night until 5 to 6 A. M., and then decreases until 10 A. M., whereas the temperature

falls steadily until from 5 to 6 A. M., (the hour of the second maximum of horizontal intensity,) and after that begins to rise. Thus the one curve has two maxima and two minima, and the other one maximum and one minimum. 2. While the temperature falls in the afternoon and evening as rapidly as it rises in the forenoon, the horizontal force decreases less rapidly during the former period than it increases during the latter; and at the same time, as already intimated, the maximum of horizontal intensity frequently occurs an hour or two later than the maximum of temperature.

Figs. 1, 2, 3, 4, 5.

Curves of the Mean Diurnal Variations of the Horizontal Force for 1844 and the different quarters of the same year.



I. Jan., Feb. and March.—II. April, May and June.—III. 1844.—IV. July, Aug. and Sept.—V. Oct., Nov. and Dec.

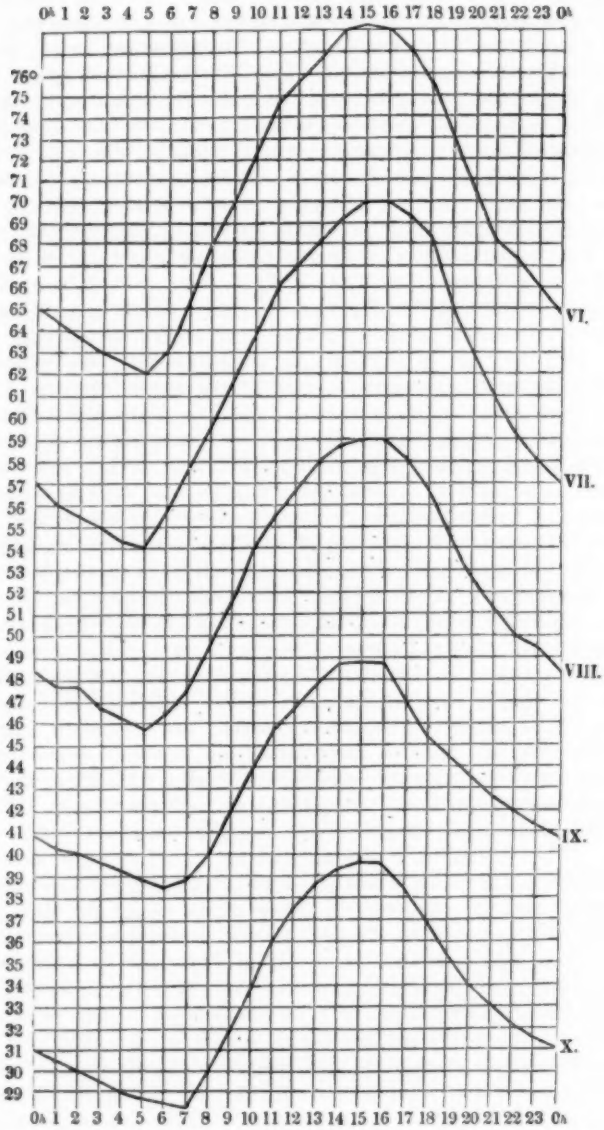
Increase of numbers corresponds to decrease of force. One division of Magnetometer scale = ·000036 of horizontal force.

How are we to account for these discrepancies between theory and fact—these deviations of the actual daily variations of the horizontal force from the theoretical variations? To distinguish them from those which have just been considered, and which accord with our theory, let us call them the *secondary variations* of the horizontal force, without meaning thereby to intimate that they are of minor importance. The inevitable in-

ference from the first mentioned fact, is that if the daily variation of temperature is one cause of the daily variation of the horizontal force, there must also be some other cause in operation besides the mere variation of temperature. Is this cause one entirely unconnected with the variation of temperature, or is it some indirect effect of this variation? The Newtonian principle of not multiplying causes would prompt us to try the latter supposition. Besides a connection exists between the time of the secondary maximum of horizontal intensity and the time of maximum temperature, which serves to render it probable that this supposition is the true one. This connection may be inferred not merely from their coincidence in the mean curves for the year, but also from their approximate coincidence in the different curves for the quarters of the year (see figs. 1, 2, 3, &c., to 10);—in other words, from the fact that the time of the secondary maximum of horizontal intensity moves forward and backward, during the year, with the time of sunrise. It should be observed, however, that this fact is less distinctly shown by the curves for some years than for others. It has been recognized by Professor Loyd, in his observations at Dublin. He says, "The epoch of the morning maximum moves forward as the time approaches the winter solstice, appearing to depend upon the hour of sunrise which it precedes by a short interval." The manifest inference from this connection is that the increase of the horizontal force during the latter part of the night, when the temperature is on the decrease, and the decrease of this force for several hours after sunrise, when the temperature is on the increase, are in all probability indirect effects of the change of temperature. While making a hasty comparison of the daily variations of the horizontal force with the theory that its intensity varies with the temperature, about a year since, it occurred to me that the secondary changes of this force, just noticed, were probably due to the deposition of condensed vapor from the atmosphere during the night, and the evaporation which immediately succeeds in the morning. These are well established effects of the daily fall and rise of temperature. The tendency of the deposition of vapor that goes on while the temperature is falling, must be to augment the horizontal force, and the tendency of the evaporation of the dew that falls at night, produced by the heat of the sun in the morning, must be to diminish this force. The deposition of vapor must tend to increase this force in two ways; viz., by the heat given out in the act of condensation, and by adding to the amount of matter at the earth's surface which acts upon the needle. The evaporation must also tend to diminish the force in two ways; viz., by the loss of sensible heat accompanying the vaporization, and by the loss of a certain amount of matter, from the earth's surface, whose horizontal magnetic action had formed a part of

Figs. 6, 7, 8, 9, 10.

Curves of the Mean Diurnal Variations of the Temperature, for 1844, and the different Quarters of the same year.



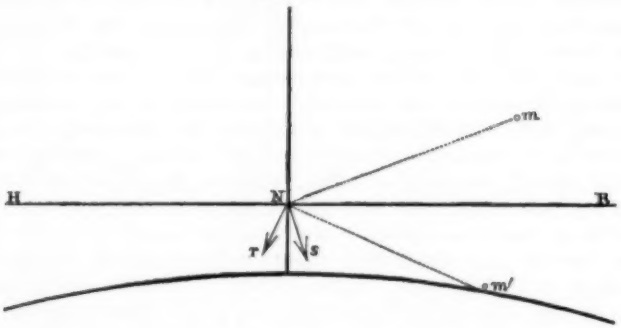
VI. July, Aug. and Sept.—VII. April, May and June.—VIII. 1844.—IX. Oct., Nov. and Dec.—X. Jan., Feb. and March.

the horizontal force. It would seem that the increase of the horizontal force during the night and decrease in the morning, cannot be attributable solely to the heat given out by condensation and abstracted by vaporization, since, notwithstanding the deposition of vapor at night and the evaporation in the morning, the temperature continues to fall until morning, and after that rises steadily during the forenoon:—unless it should chance that a considerable portion of the heat evolved by the condensation penetrates below the surface, so as to augment the average temperature of the stratum which is subject to daily variations of temperature, and that, in like manner, the cooling due to evaporation lowers the average temperature of this stratum, at the same time that the surface temperature rises. I am disposed, therefore, to attribute the secondary variations of the horizontal intensity, under consideration, chiefly to the variations in the quantity of condensed vapor at the earth's surface, attending the fall and rise of temperature. But, whether the morning maximum and minimum are principally effects of variations in the quantity of magnetic matter in action, or of variations in the absolute amount of sensible heat due to the fall and rise of vapor, the effect in a given time, will on either supposition, be proportional to the amount of vapor deposited or of water evaporated. When we consider the entire secondary variations during the night, it is to be observed that, upon the view which I have adopted, the fall of vapor has two effects; it diminishes the rate of cooling of the earth, by the heat evolved, which makes the decrease of horizontal force less, and it augments the quantity of magnetic matter in action, which makes the diminution of this force still less, or converts the decrease into an increase, according to the amount of vapor deposited. In like manner the evaporation after sunrise has two effects. If any heat be evolved or abstracted, in addition to that connected with the variations of temperature at the surface produced by the rise and fall of vapor, it will conspire with the changes in the quantity of condensed vapor acting upon the needle, to produce an augmentation of the horizontal force during the forenoon.

Before presenting the considerations which I have to urge in support of the theory which I have now advanced, let me consider an objection which has probably occurred to the reader; viz., that the quantity of vapor that falls during the night is altogether too trifling to produce an effect so considerable—to more than neutralize the effect of the decrease of temperature; and, in like manner, that the loss of matter from the surface of the earth, by reason of the evaporation in the forenoon, is too small, in comparison with the whole amount of matter which has a variable action upon the needle, to have the effect attributed to it.

In answer to this objection, I have to offer the following considerations. 1. It is to be observed that the entire horizontal magnetic force of the vapor is added or abstracted with it, while the horizontal force is otherwise affected only by the variations of temperature. 2. The force of the vapor, which, from a situation above the needle falls below it, is changed from a diminishing to an increasing action. This will be readily seen on referring to fig. 11; in which N represents the position of the needle,

Fig. 11.



and H N R a horizontal line at the height of the needle and situated in the plane of the magnetic meridian. A particle m, in this plane will exert its force in the direction Ns, and therefore tend to diminish the horizontal force (R being supposed to be south of N), but when it falls to the position m' it acts in the direction Nr, and therefore now tends to increase the horizontal force. It is here taken for granted that a particle continues to act magnetically after it has left the earth's surface. It is only by a detailed discussion that we can determine whether this supposition be true or not. It is enough, for our present purpose, that it is not at variance with the theory. 3. The depth to which any considerable daily variations—or at least variations which indicate a change in the absolute amount of heat—extend, does not probably exceed nine inches. For, according to the observations of Quetelet, Director of the Observatory at Brussels, made from 1834 to 1839, the velocity of propagation of the diurnal variations of temperature is less than $1\frac{1}{2}$ inches per hour, or less than 18 inches in twelve hours; and, the variations of temperature will be very much less below the depth of nine inches than above it. We may form some estimate of the difference from the following statement of the annual variations of temperature at various depths, given by Quetelet. The depths are in metres, and the degrees Centigrade.

Depth.—Metres.	Annual Variations.
0·19	13° 28
0·45	12 ·44
0·75	11 ·35
1·00	10 ·58
1·95	7 ·59
3·90	4 ·49
7·80	1 ·13

They become entirely imperceptible at the depth of about 24 m. If we suppose the daily variations of temperature to decrease from the surface downwards at the same proportionate rate, it will become less than 1° F. at the depth of 9 in., (taking the variation at the surface at 12° F., which is about the average for the year.)

4. Although the amount of vapor deposited during the night, may perhaps not exceed the $\frac{2}{1000}$ of an inch, on the average, the loss of its entire amount of sensible heat may still be more than an equivalent for the daily variations of temperature of a depth of six or nine inches of soil.

In view of these statements it will not be deemed idle to enquire whether the alternate deposition and rise of vapor may not afford an adequate explanation of the secondary variations of the horizontal force. But before entering upon this enquiry, let us go back, and following the indications of the observations endeavor to ascertain whether there is any known phenomenon that satisfies the prominent conditions which they furnish. As preparatory to this it is important to state the laws according to which heat is radiated from the earth's surface into space, and propagated from particle to particle below the surface. These are as follows,

1. The loss of heat, from nocturnal radiation, in a calm clear night, is uniform at all temperatures. This law, we are told (see the No. of this Journal for November, 1848, p. 420), has recently been announced by Wilson, and has since been confirmed by the Observations of Melloni. It is, moreover, in approximate accordance with the general theory of radiation. The formula which this theory, in conjunction with experiment, has furnished, for the velocity or rate of cooling of a body by radiation is

$$V = ma^{t+\theta} - ma^{\theta} \quad . \quad . \quad . \quad . \quad . \quad (1.)$$

in which θ denotes the absolute temperature of the enclosure, or external medium, toward which the body radiates, and t the excess of the temperature of the body over that of the enclosure. If θ and t are expressed in Centigrade degrees, then $a = 1{\cdot}0077.m$, for a vitreous surface, is 2·037; and it is about the same for the soil, which has about the same radiating power as glass. According to Pouillet the temperature of space is about −142° C.

If we denote the temperature of the earth, in Centigrade degrees, by T, we shall have for the velocity of cooling of the earth, by radiation into space,

$$V = 2{\cdot}037\left((1{\cdot}0077)^{T} - \frac{1}{(1{\cdot}0077)^{148}}\right) = 2{\cdot}037\left((1{\cdot}0077)^{T} - {\cdot}339\right)$$

According to this formula the velocity of cooling of the earth's surface at 0° C., (32° F.,) is to the velocity of cooling at 15° C., (59° F.) as 67 to 78—that is, the rate of cooling diminishes, from 59° F. to 32° F., $\frac{1}{7}$ of its amount at 59°.

Formula (1) was obtained by a comparison of theory with the experiments of Petit and Dulong. It may well happen that when we come to apply it to a case in which the temperature of the medium exterior to the cooling body is far below the range of the experiments, it will not give exact results.

In the application of this formula, I have supposed the radiation of the earth to be directly into free space. As a matter of fact, it is through the atmosphere, and therefore the rate of cooling of the earth must depend upon the mean temperature and also the absorptive action of the atmosphere. To apply formula (1) to the case of the earth, θ should therefore be taken equal to the temperature of the sky, instead of the temperature of space: or, we may introduce into the formula another subtractive term, representing the emissive power or absolute radiation of the atmosphere. We must also allow for the absorption of heat by the atmosphere. Pouillet estimates this at a little less than $\frac{1}{2}$. Supposing it to be $\frac{1}{2}$, and also that $\frac{1}{n}$ of the heat radiated downward from the air reaches the surface of the earth, and denoting by t the mean temperature of the air, we have

$$V = ma^{T} - \frac{ma^{\theta}}{2} - \frac{ma^{t}}{n} \quad . \quad . \quad . \quad . \quad (3.)$$

It appears from the observations made by Pouillet with the actinometer, that the mean temperature of the atmosphere is about 35° C. below the temperature of the air, and falls, during the night, at about the same rate as the temperature at the earth's surface. Taking this result, and making the calculations for $n = 1$, we find the velocities of cooling at 32° F. and 59° F. to be to each other as 77 to 86, or that the diminution is a little more than $\frac{1}{10}$ of the velocity of cooling at 59° F. According to Pouillet, the absorptive power of the entire atmosphere for terrestrial heat is greater than 0·8, but as the heat radiated downwards from the atmosphere passes only through a portion of it, the value of $\frac{1}{n}$ is doubtless less than 0·8. It is to be taken into account

also, that the difference between the mean temperature of the air and the temperature at the earth's surface appears to be, in general, from 3° to 5° C. lower at the end than at the beginning of a night. This being done, and $\frac{1}{n}$ being taken equal to 0·5, the rates of cooling at the beginning and end of a night, upon which the thermometer falls from 59° to 32°, are found to be nearly as 47 to 46, or very nearly equal.

The experiments of Melloni and others have established, "that the portion of the sky concerned in the radiation is included within 30° to 35° of the zenith;—that clouds beyond this have but little interfering effect."

The air cools, by radiation into space and the upper regions of the atmosphere, like the surface of the earth, by radiation to the earth's surface which cools more rapidly than the air from its superior radiating power, by contact with the earth and objects connected with the earth, and by condensation. The difference between the temperature of the earth's surface and of the air at the height of four or five feet may amount to several degrees. The most recent experiments upon nocturnal radiation, viz., those of Melloni, have established, "that while under certain circumstances some bodies can be cooled to 8° C. below the temperature of the air four or five feet above, in general, the effect of radiation is to reduce the temperature of vegetation, &c., not more than 2° below that of the surrounding air." Ordinarily the agitations of the air will be sufficient to establish very nearly an equilibrium of temperature between it and the earth's surface.

2. Heat is propagated from one particle to another of the earth's mass by ordinary radiation. Hence when two contiguous particles have the same temperature they exchange, by reciprocal radiation, equal quantities of heat, and when their temperature is different, the one will gain and the other lose, in a given time, an amount of heat proportionate to their difference of temperature. The rate at which this gain or loss takes place in any body, constitutes its conductibility. If we conceive the matter near the earth's surface to be divided into layers of particles, of indefinitely small thickness, in the cooling of the earth at night the heat lost by any one layer is gained by that next above it. The flow of heat from below upward will diminish the fall of temperature at the surface of the earth; and the velocity of flow will be proportionate to the difference of temperature of the first and second layer. As the cooling goes on this difference will increase, and at the same time the difference between two consecutive differences will become less, and therefore the velocity of cooling will diminish. If the night were to continue for an indefinite time, this change would go on until the first differences attained to a maximum value, and the second differences became zero, when

the earth would have attained to a "movable equilibrium" of temperature. Pouillet has calculated that this would be the case at the temperature of $-89°$ C. Taking the fundamental principle that one layer gains what the next below it loses, we can derive a very simple formula, connecting the loss of heat at the surface of the earth in a given time with the losses of temperature of the different layers during the same interval of time. Let L = absolute loss of heat at the earth's surface, in a given time, by nocturnal radiation; l, l', l'', &c., denote the losses of temperature of the first, second, third, &c. layers in the same time; a, a', a'', &c., the quantity of heat received by the successive layers from the layer next below. Then $L=l+a$, $a=l'+a'$, $a'=l''+a''$, &c., and hence

$$L=l+l'+l''+l'''+\text{&c.} \quad . \quad . \quad . \quad . \quad (4.)$$

The losses of temperature, l, l', l'', &c., of the different layers decrease with the depth, and for a night of twelve hours become zero at the depth of about eighteen inches. After sunrise, when the temperature at the surface is rising, the losses of temperature will still continue with the layers below the surface until the heat propagated downward reaches them in succession, and the cooling will gradually extend below 18 in., but these variations of temperature are not attended with any absolute loss of heat. It appears from observation that the law of decrease of the annual variations of temperature at different depths is that of a geometrical progression for depths which increase in an arithmetical progression. The same law probably holds good for the entire diurnal variations. The losses during the night simply probably decrease more rapidly, for, while the entire fall of temperature at and near the surface is about the same as for the night, lower down it is greater, and for a number of inches below 18 in. takes place during the day.

It is to be observed that formula (4) is equally applicable if we suppose L to represent the absolute loss of heat from the combined action of all the causes which affect the temperature of the surface. The same relation also obtains between the gain of heat during the day and the increments of temperature at different depths.

Since the loss of heat, L, by nocturnal radiation from the earth's surface is the same at all temperatures, for any given interval of time, it follows that whatever may be the variations of l, l', l'', &c. during the night, the actual loss of heat from the whole stratum which undergoes a daily variation of temperature, occasioned by nocturnal radiation, is uniform at all temperatures. Accordingly any variations of l that may arise from the flow of heat towards the surface cannot be the cause of the observed variations of the horizontal magnetic intensity during the night.

Notwithstanding such variations of l, the horizontal force, as it depends only on the absolute quantity of heat, would decrease uniformly during the night.

Having laid down these general principles, let us enter upon the general enquiry to which the statement of these principles is preliminary. If we compare the nocturnal variations of the horizontal force with those of the temperature, as shown by the curves, (see figs. 1, 2, &c. to 10,) we find that the deviations from uniformity in the diminution of the horizontal force are attended with like deviations in the fall of the thermometer:—thus, while the thermometer falls less and less rapidly as the night advances, the diminution of the horizontal force becomes less and less; also, while during the fall and winter months the fall of temperature during the night is materially less than in the spring and summer months, the nocturnal diminutions of the horizontal force are less. It is true that the diminution of the horizontal force gradually passes into an increase, but this is only the result of a certain increase in the amount of the deviation from uniformity of diminution. The deviations therefore are of the same character—lie continually in the same direction—for the temperature and horizontal force. They are also cotemporaneous; they differ only in proportionate amount. We have therefore to seek for the cause of the secondary variations of the horizontal magnetic intensity of a place in the cause, whatever it may be, of the changes in the rate of diminution of the temperature during the night, and from one season to another. The former cause is probably identical or closely connected, physically, with the latter, but it is possible that the connection may be more or less remote, or even that the correspondence between their variations is accidental. Now the cause of the nocturnal inequality of temperature must be found in some phenomenon or fact connected either with the relations of the surface of the earth to the atmosphere, or with its relations to the matter below the surface. If it be a meteorological phenomenon, we may suppose it to consist in variations in the clearness of the sky, in the quantity of rain, in the quantity of dew, or, speaking more generally, of vapor deposited in other forms than that of rain, in the direction and force of the wind, and in the amount of heat absorbed by the atmosphere or exchanged with it. We may reject the phenomenon last mentioned at once; for, as we have seen, in a calm clear evening the nocturnal radiation is uniform at all temperatures, and this radiation is the actual radiation, one element of which is the exchange of heat with the atmosphere, and another the absorptive action of the atmosphere. If it be surmised that it is only the maximum radiation on clear evenings that is uniform at all temperatures, such is not the statement of the law, and if it were, then the uniformity must be independent of the density

of the air and of the quantity of vapor suspended in it; and if it be independent of the density of the air it must be independent of the density of the vapor, so long as this retains the aeriform state. It is also independent of any differences that may subsist between the temperatures and densities of the different strata of the atmosphere, for it is a well established fact that the temperature falls more rapidly, as we ascend in the atmosphere, in a summer than in a winter night. In other words, it holds good whatever may be the state of all the various particulars upon which the absorptive action of the atmosphere when transparent, can be supposed to depend.

As for the relative clearness of the sky, I find, on referring to the Report of the Meteorological Observations made at Philadelphia, that during a period of two years and three months, viz., from March, 1843, to July, 1845, the average clearness of the sky was somewhat greater after midnight than before it. The following numbers show the averages of the

Mean Sky Covered by Clouds.

	From 6 P. M. to midnight.	From midnight to 6 A. M.
1843 (from March),	·63	·59
1844,	·72	·62
1845 (to July),	·64	·61

The numbers for the different quarters of years are as follows:

Mean Sky Covered by Clouds.

		From 6 P. M. to midnight.	From midnight to 6 A. M.
1843.	April, May, June,	·53	·51
	July, Aug., Sept.,	·66	·66
	Oct., Nov., Dec.,	·72	·59
1844.	Jan., Feb., March,	·71	·62
	April, May, June,	·90	·83
	July, Aug., Sept.,	·65	·56
	Oct., Nov., Dec.,	·61	·56
1845.	Jan., Feb., March,	·61	·60
	April, May, June,	·67	·63

For the entire night, from 6 P. M. to 6 A. M., we have—

	1843.	1844.	1845.	Average.
Jan., Feb., March,	. .	·66	·60	·63
April, May, June,	·52	·86	·65	·67
July, Aug., Sept.,	·66	·60	. .	·63
Oct., Nov., Dec.,	·65	·58	. .	·61

These numbers show that during these years the clearness of the sky was no greater from March to October than during the first and last quarters of the year, and therefore that the more rapid fall of the temperature at night toward the middle of the year, than toward the beginning and end of it, during the inter-

val of time embraced in the above table, cannot be ascribed to a greater average amount of nocturnal radiation resulting from a greater clearness of sky.

For the years 1841–2, the observations only furnish the averages for the entire day, of twenty-four hours. These, with the averages for 1843 and 1844, and from January to June, 1845, are as follows:

	1841.	1842.	1843.	1844.	1845.
Jan., Feb., March, .	·63	·55	. .	·80	·65
April, May, June, .	·56	·49	·59	·92	·72
July, Aug., Sept., .	·48	·52	·75	·70	. .
Oct., Nov., Dec., .	·59	·44	·79	·67	. .

These numbers serve only to confirm and extend the conclusion drawn from the previous table.

The following table, giving for each quarter of the year the mean number of days, during the years 1839, 1840–1, and parts of 1838 and 1842, on which the wind prevailed, at 9 P. M. and 3 A. M., from each direction, at Washington, will furnish the means of judging of the influence of particular directions of the wind.

		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January, &c. . . .	9 P. M.	6·1	10·0	7·5	5·0	12·3	11·1	8·5	15·5	15·5
	3 A. M.	6·1	10·7	6·0	3·0	11·3	11·5	6·0	16·8	17·8
April, &c.	9 P. M.	4·6	9·7	3·3	8·0	11·0	8·7	9·3	11·6	22·8
	3 A. M.	4·8	13·7	4·6	8·3	6·0	12·0	9·6	11·0	19·2
July, &c.	9 P. M.	5·6	5·0	4·0	7·3	9·7	9·0	10·5	11·1	21·6
	3 A. M.	6·2	10·9	5·7	3·6	5·4	14·3	9·3	11·0	20·0
October, &c. . . .	9 P. M.	6·8	12·3	7·8	2·7	6·8	11·0	8·3	19·0	16·3
	3 A. M.	9·5	12·0	6·9	4·2	3·8	9·7	7·7	22·4	17·4
Entire year, . . .	9 P. M.	23·1	37·0	22·6	23·0	39·8	39·8	37·1	57·2	76·2
	3 A. M.	26·6	47·3	23·2	19·1	26·5	47·5	32·6	61·2	74·4

From this table we derive the following, showing the relative frequency of the cold and warm winds.

		N., N.E., W., N.W.	E., S.E., S., S.W.
January, &c.	9 P. M.	40·1	35·9
	3 A. M.	39·6	31·8
October, &c.	9 P. M.	46·9	28·3
	3 A. M.	51·6	24·6
		N., N.W., N.E., E.	S., S.W., S.E., E.
April, &c.	9 P. M.	29·2	37·0
	3 A. M.	34·1	35·9
July, &c.	9 P. M.	25·7	36·5
	3 A. M.	33·8	32·6
		N., N.W., N.E.	S., S.W., S.E.
Entire year,	9 P. M.	117·3	102 6
	3 A. M.	135·1	93·1

On examining these tables, it will be seen that calms are about equally frequent before and after midnight, and that cold winds are rather more frequent and warm ones less so, throughout the

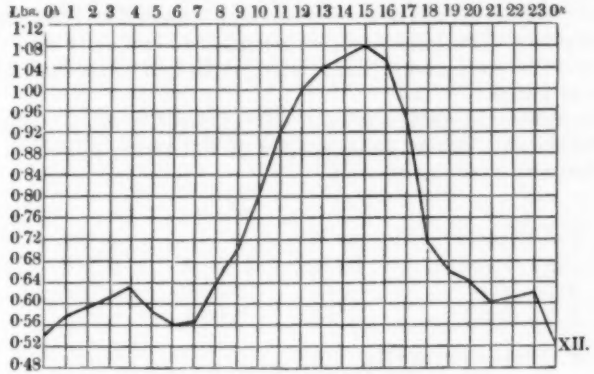
year, after than before midnight. It appears also that cold winds are more prevalent, and warm winds less so, in the first and last than in the middle quarters of the year. Both of these facts are opposed to the idea that difference of direction of wind may be the general cause of the diminution in the hourly decrement of temperature as the night advances, and in the nocturnal decrease of temperature from the warm to the cold months.

If we reject the N.E. and W. winds from the list of cold winds, that is, regard them as not affecting the mean temperature, in the colder months, cold winds will still be as prevalent after midnight as before: and if we reject the W. wind, in the warm months, from the list of warm winds, it will still be true that warm winds will prevail no more in these months after midnight than before. But upon these suppositions the cold winds will become more frequent in summer than in winter in the proportion of 31 to 22, and the warm winds less frequent in the proportion of 27 to 33: and both cold and warm will occur with about the same degree of frequency in summer as in autumn. It is to be observed, however, that the relative cooling effect of northerly winds in different seasons is not in exact proportion to their relative frequency, for the relative force of the wind is to be taken into account. Now it appears on examining the curves showing the force of the wind in the different quarters of the years 1843–4–5 at Philadelphia, that the force of the wind at night is from two to three times greater from September to April than from March to October. If we connect with this the facts, that the strong winds in winter are most frequently from the N.W., and that, as shown by the first of the above tables, N.W. winds are much more frequent during the former than the latter of the above mentioned period, it will be seen that there is little room to doubt that the greater nocturnal decrease of temperature in the summer than in the winter, must be due to some other cause than the differences, generally subsisting, between the directions of the wind in these seasons. If there be any lingering doubt upon this point, it will be removed, if we reflect that the law of variation of the nocturnal decrease of temperature from one season to another, which we have been considering, is as true for one place as for another. It is found to hold good, with occasional partial exceptions, at all places, both in this country and Europe, where meteorological observations have been made. In fact, this law is essentially connected with the general fact that the loss of temperature, by nocturnal radiation, is equal to the daily rise of temperature, both in January and July. So universal a law cannot, it is believed, be dependent upon the direction of the wind, since the prevalent winds are often very different in different localities.

The question of the influence of the force of the wind follows next in order. Fig. 12 exhibits the mean variations of the force of the wind during the year 1844.

Fig. 12.

Curve of the Mean Diurnal Variations of Force of Wind for 1844, in Lbs.



On inspecting this curve it will be seen that the force of the wind is nearly the same before and after midnight, and that its principal variations occur during the day. The same law is shown by the curves for other years, and for quarters of years, so far as given. The nocturnal loss of temperature cannot therefore be materially modified by variations in the force of the wind, in the average of months and years. The curve showing the variations in the average force of the wind from month to month, which cannot conveniently be given here, indicates that the wind is highest in February or March, and is much higher during the first and last quarters of the year than toward the middle of the year. Since these strong winds are more apt to be from the N.W. than from any other quarter, their tendency will be to cause the temperature to fall more during the night, in the fall and winter, than in the spring and summer, instead of less as it does in fact.

Let us next consider whether it may chance that the variations in the nocturnal loss of temperature which I have specified, are due to the cooling or heating effect of rain. The observations in my possession do not furnish me with the means of making any but a very partial examination of the relative quantities of rain that fall during the first and last halves of the night. But the following facts will serve to show that the influence of rain, whatever it may be, can have no part in determining the law of the decrease of temperature for a single night. 1. Of twenty-one term days, observed at Washington, for which the curves of the daily variation of temperature are given, there are only five exceptions to the general fact that the temperature falls most slowly during the latter half of the night. 2. Of twenty-three days observed in Philadelphia, in October, 1843, there are but six exceptions to the same general fact. We may conclude from these facts, that

the slower rate of cooling after midnight is too common a phenomenon to depend upon rain, or prevailing direction or force of wind. Moreover, of the seventeen days observed at Washington, on which the law held good, as a matter of fact only two were rainy. The exceptional days were, with one exception, either rainy or foggy.

The following table shows the total quantity of rain that fell at Philadelphia during each quarter of the years 1842–3–4, and the first two quarters of 1845.

	1842.—Inch.	1843.—Inch.	1844.—Inch.	1845.—In.
Jan., Feb., March, . .	6·29	4·710	7·305	6·503
April, May, June, . .	10·59	10·330	5.244	6·604
July, Aug., Sept., . .	11·39	15·704	10·787	. .
Oct., Nov., Dec., . .	7·85	8·672	8·017	. .

Now, if we compare the numbers for 1844 with the mean nocturnal losses of temperature, in the different quarters of this year, which are 11°, 16°, 16°, 10°, we see that while the fall of temperature is the same for the two middle quarters of the year, the quantity of rain fallen is about twice as great for one of them as for the other. The cloudiness of sky for these periods is ·92 for the first, and ·70 for the second. Again for the middle quarters of the year 1843 the quantities of rain are $10^{in}{\cdot}3$ and $15^{in}{\cdot}7$, while the decrements of temperature are 15° and 12°—the reverse of what should be the fact, since if rain is the determining cause of the greater loss of temperature in a summer night, it can only have this effect by cooling the earth in summer and warming it in winter. These statements are sufficient to make it evident that the cause we are seeking does not consist in variations in the quantity of rain that falls at different seasons. The truth of this conclusion may be confirmed by the consideration already urged, in considering the influence of the wind, that the laws of the variation of the nocturnal loss of temperature are too general to depend upon a cause which must differ so much in its effects in different places.

It will have been observed that in considering the question of the influence of variations in the cloudiness of the sky, it was tacitly implied that the numbers representing the proportion of sky covered by clouds represented also the proportion of that part of the sky which is concerned in the nocturnal radiation, that was covered by clouds. This it will be recollected, is the part which lies within 30° or 35° of the zenith. Now it is not difficult to see that this portion of the sky will be, in the average of months, less cloudy than other parts, and especially than the parts near the horizon. For, the clouds in the horizon are much more distant than those of the zenith, and consequently are seen very obliquely, and as they are generally of considerable thick-

ness, and there are often several layers at different elevations, they will be frequently projected upon each other. Or the case may be stated thus; if we suppose isolated clouds to be scattered uniformly throughout the cloudy stratum, the line of sight which makes a small angle with the plane of the horizon will cross this stratum very obliquely, and be proportionally more likely to meet with a cloud than a line traversing this stratum perpendicularly at the zenith. Besides from the obliquity of this line a haziness which would scarcely be observed in the zenith might amount to a positive cloud at a distance from the zenith. This is well illustrated when a fog or mist is gradually being dissipated, and the sky is first seen in the zenith.

In this way it may very well happen that, although there may be considerable differences among the numbers representing the cloudiness of the sky in general, for the quarters of years, there may be no material variations in the nocturnal decrements of temperature, corresponding to these differences.

(To be continued.)

ART. V.—*On the Theory of Numbers;* by J. B. LUCE.

HAVING read with much satisfaction, in the American Journal of Science and Arts, the very ingenious method of interpolations, as explained in a plain, elegant and very satisfactory manner by J. H. Alexander; it induces me to send you my new theorem in the theory of numbers. I call it new, because it is probably so, having never read it in any treatise on the theory of numbers, and particularly in that of Peter Barlow, who, as it is well known, published a useful and elegant book on these matters.

The equation $p^2 - nq^2 = 1$ is well known to be a fundamental one in the resolution of indeterminate problems of the second degree, since, in frequent cases, this solution depends on the finding of integral values for p and q. I use here the same symbols as Peter Barlow. But not having now with me his book, I do not recollect precisely the method he uses to find integral values for p and q; all I remember is that it is performed by a long and tedious process of continued extractions of the square root of n, coëfficient of q^2, a method which I laid aside since the finding of the theorem which I am going to expose, and may, in all circumstances, supply the old method.

I propose to myself the resolution of the more general equation $x^2 - ny^2 = z^i$, where i may be 0, 1, 2, 3, &c. It is evident that we can always assume $n = a^2 \pm b$. Hence $\sqrt{n} = \sqrt{a^2 \pm b}$. Assume $\sqrt{a^2 \pm b} = a \pm f$, which gives $f^2 \pm 2af = \pm b$; which expanded in a continued fraction, and, for abbreviation's sake, putting

$\frac{2a}{b}=m$, is

$$\sqrt{n}=a\pm\cfrac{1}{m\pm\cfrac{1}{2a\pm\cfrac{1}{m\pm\cfrac{1}{2a\pm\cfrac{1}{m\pm}}}}}$$ &c., ad infinitum, where the square root of any number n, either integral or fractional, is transformed into a continued fraction, and may be converted into a series of converging fractions as follows,

$$\frac{a}{1},\ \frac{am\pm1}{m},\ \frac{2a^2m\pm3a}{2am\pm1},\ \frac{2a^3m^2\pm4am+1}{2am^2\pm2m},\ \frac{4a^3m^2\pm10a^2m+5a}{4a^2m^2\pm6am+1},\ \text{&c.}$$

If instead of m we supply its value $\frac{2a}{b}$, we shall have the following converging fractions:

$$\frac{a}{1},\ \frac{2a^2\pm b}{2a},\ \frac{4a^3\pm3ab}{4a^2\pm b},\ \frac{8a^4\pm8a^2b+b^2}{8a^3\pm4ab},\ \frac{16a^5\pm20a^3b+5ab^2}{16a^4\pm12a^2b+b^2},\ \text{&c.}$$

Now, if in the equation $x^2-ny^2=z^i$, we assume $x=$ the numerator, and $y=$the denominator of successively the first, second, third, &c. fraction, according as $i=0, 1, 2, 3$, we shall have $a^2-n=\mp b$; $(2a^2\pm b)^2-n\times4a^2=b^2$; $(4a^3\pm3ab)^2-n(4a^2\pm b)^2=\pm b^3$, &c. Thus when i is an odd number, every odd power of z shall be positive if $n=a^2-b$; and negative if $n=a^2+b$.

Let us apply this theorem to some examples; and in the first place let it be proposed to find the expression of a right angled triangle, or solve the equation $x^2+y^2=z^2$.

Here $n=-1$. We may assume $-1=\frac{a^2}{\beta^2}-\frac{a^2+\beta^2}{\beta^2}$; which gives $a=\frac{\alpha}{\beta}$, and $b=\frac{a^2+\beta^2}{\beta^2}$. By placing these values instead of a and b in our second converging fraction $\frac{2a^2-b}{2a}$, we obtain $\frac{a^2-\beta^2}{2a\beta}$, and the numerator $a^2-\beta^2=x$, and the denominator $2a\beta=y$, where a and β may be any number assumed at pleasure. If we assume $\beta=a-1$, we find $x=2a-1$, $y=2a(a-1)$, and taking successively $a=1, 2, 3, 4$, &c., we obtain the following series,

$x=$ 3, 5, 7, 9, 11, 13, &c.
$y=$ 4, 12, 24, 40, 60, 84, &c.

and assuming $\beta = \alpha - 3$, it is $x = 3(2\alpha - 3)$, $y = 2\alpha(\alpha - 3)$,
which gives $x = 15, 21, 27, 33, 39$, &c.
and $y = 8, 20, 36, 56, 80$, &c.

By assuming $\beta = \alpha - 5$, we find
$x = 35, 45, 55, 65$, &c.
$y = 12, 28, 48, 72$, &c., and so of others.

This problem, of course, has been most satisfactorily answered by all who have written on the theory of numbers; and I have proposed it only as an illustration of our theorem. But as a further illustration, let us come to some new problems.

Let it be required to find three numbers such, that the square of the first shall bear the same arithmetical proportion to the square of the second, as this does to the cube of the third.

Here we have to solve the equation $x^2 + z^3 = 2y^2$, or $x^2 - 2y^2 = -z^3$. I assume $n = \frac{\alpha^2}{\beta^2} + \frac{(\beta^2 n - \alpha^2)}{\beta^2}$, which gives $a = \frac{\alpha}{\beta}$, and $m = \frac{2\alpha\beta}{\beta^2 n - \alpha^2}$. I put these values of a, and m, in our third converging fraction, and find $x = \alpha^3 + 3\alpha\beta^2 n$, and $y = 3\alpha^2\beta + \beta^3 n$, where α, β, n, may be any number ad libitum. But in the present example $n = 2$, and in order to have the least integral numbers that satisfy the conditions of the problem, we must take $\alpha = 1$, $\beta = 2$; and the result is $x = 25$, $y = 22$, and $z = 7$.

It is required to find two arithmetical proportions, each composed of the four least possible numbers, such that the sum of the terms of the one shall be equal to the sum of the terms of the other; and such at the same time, that the sum of the cubes of the two middle terms subtracted from the sum of the cubes of the two extremes, shall, in each case, leave the same cube.

Answer, 19, 17 : 7, 5.
17, 13 : 11, 7.

I do not work these problems, my object being to come to the equation $p^2 - nq^2 = 1$, which is of greater importance. I only mention them to show the nature of problems that this method solves with the greatest ease: and indeed there is scarce any indeterminate problem of the second, and higher degrees, that it would not solve; in so much that this theorem may perhaps become, in better hands, the fundamental one of the theory of numbers, especially if it solves the equation $p^2 - nq^2 = 1$.

Since $n = a^2 \pm b$, and $m = \frac{2a}{b}$, it follows evidently that if $\frac{2a}{b}$ is a whole number, by placing its value in the second converging fraction $\frac{am \pm 1}{m}$, we shall obtain $p^2 - nq^2 = 1$. For instance, let $n = 11 = 9 + 2$, from which we infer $a = 3$, $m = \frac{2 \times 3}{2} = 3$. Hence

$p=am+1=10$, and $q=m=3$; and it is $10^2-11\times3^2=1$, without the necessity of continued extractions.

When n is such that we can obtain a whole number for $\frac{2a}{b}$, I call n a *simple number;* and when such that $\frac{2a}{b}$ is a fraction, it is called a complex number. Thus the problem is already solved in a simple and easy manner for at least half all numbers that are likely to be needed, since the simple numbers exceed the complex in the table of complex numbers hereafter presented.

When n is complex, we must find a square factor by which n being multiplied, the product shall be a simple number. For if a^2 be that factor, we shall have $p^2-na^2y^2=1$: but $a^2y^2=q^2$, therefore it will be $p^2-nq^2=1$.

For instance, $13=9+4$, is a complex. But if I multiply 13 by 5^2, or 25, the product $325=18^2+1$, which is a simple number. Hence $a=18$, $m=36$, and $p=am+1=18\times36+1=649$; and $y=m=36$; wherefore, $p^2-13\times5^2\times y^2=649^2-13\times180^2=1$.

The finding of these square factors is a very nice problem, and in some particular cases, rather intricate. The least number that will make 109 a simple number is $(851325)^2$. I shall not presume to lay down any certain and satisfactory rules for the finding of them; I shall only content myself with a few hints on that subject.

When we have obtained the least values of x and y, in the equation $x^2-ny^2=1$, we can readily obtain the least values of p and q, in the equation $p^2-4nq^2=1$. For if y be an even number, $y^2=4q^2$, or $q=\frac{1}{2}y$, and $p=x$. But if y be an odd number, then will $p=2x^2-1$, and $q=xy$. For by hypothesis, we have $x^2-ny^2=1$. Multiply all the terms by $4x^2$, and transpose, it will be $4x^4-4x^2-4nx^2y^2=0$. Add one to each side, and it is $(2x^2-1)^2-4nx^2y^2=1$; this compared with $p^2-4nq^2=1$, shows evidently that $p=2x^2-1$, and $q=xy$.

Again, if n be divisible by any square, we can obtain the values of x, and y, without the aid of any square factor, if we have p, and q, in the equation $p^2-\frac{n}{a^2}q^2=1$.

For instance, let it be required to find $x^2-234y^2=1$. As $\frac{234}{9}=26=5^2+1$, we say $a=5$, $m=10$; and placing these values of a, and m, in the fourth converging fraction, we find $p=2a^2m^2+4am+1=5201$, and $q=1020=3\times340$, and it is $5201^2-234\times340^2=1$.

If the quotient of n by any square be of the form β^2-1, we place the values of a, and m, in the third converging fraction, since under such form we always have $(2a^2m-3a)^2-n(2am-1)^2=1$.

For instance, let $n=216=24\cdot3^2$. We have $24=25-1$, where $a=5$, $m=10$. These values placed in the third converging fraction, afford $x=2a^2m-3a=485$, and $y=2am-1=3\times33$, and it is $485^2-216\times33^2=1$.

When n does not fall under any of these cases, we are obliged to find its square factor; to do which, we must consider that simple numbers are necessarily of some of the following forms, $\beta^2\pm1$, $\beta^2\pm2$, $\beta^2\pm\beta$, $\beta^2\pm2\beta$, &c. Thus if we wish to find that series of complex numbers which require 2^2 for their factor, I assume $(6\alpha\pm3)^2+3=4n$, $(10\alpha\pm5)^2-5=4n$, $(14\alpha\pm7)^2+7=4n$, $(22\alpha\pm11)^2+11=4n$, &c., and making α successively 1, 2, 3, 4, &c., I find the series of complex numbers 3, 21, 57, 111, 183, &c., 5, 55, 155, &c., 14, 112, &c., 33, 275, &c., all of which require the factor 2^2 to become simple numbers.

In like manner, for the square factor 3^2, I shall assume $(9\alpha\pm4)^2+2=9n$, which brings 2, 3, 19, 22, 54, 59, 107, 114, 178, &c. Also, 25 $(9\alpha\pm4)^2+5=9n$, which brings 45, 70, 470, &c. all complex which are not found in the other formula.

The formula $(25\alpha\pm7)^2+1=25n$, gives 2, 13, 41, 74, 130, &c., each of which complex requires the factor 5^2.

The formula $(49\alpha\pm10)^2-2=49n$, shows that the complex 2, 31, 71, 158, &c., must be multiplied each by 7^2. From $(81\alpha\pm22)+2=81n$, we derive 6, 43, 131, 242, &c. From $(121\alpha\pm19)^2+2=121n$, we find 3, 86, 162, &c. And other similar formulæ may be found for all square factors.

If a complex be of the form α^2+4, or may be brought to that form by the multiplication of any square factor, we can readily obtain its square factor as follows:

Let it be $29=25+4$; which gives $a=5$, $m=\frac{5}{2}$. I place these values of a, and m, in the third converging fraction, and find $2a^2m+3a=140$, the half of which is 70: and $2am+1=26$, whose half is 13. Wherefore we have $70^2-29\times13^2=-1$, or $70^2+1=29\times13^2$; which shows that 13^2 is the factor of 29, since 70^2+1 is evidently a simple number.

Again. Let it be 61. This number is not of the form α^2+4; but if we multiply it by 5^2, the product $1525=39^2+4$; which worked as above, shows 3805^2 for the least square factor that will make 61 a simple number. In like manner, we find that 109×25^2 is of the form α^2+4; hence we infer that 851325^2 is the least square by which 109 must be multiplied to obtain a simple number.

It is by such, and other artifices which it would be too long to enumerate, that we have been able to construct a table of all the square factors by which every complex number must be multiplied, to obtain a simple number, up to 158.

If in the equation $x^2 - ny^2 = 1$, n be of the double form β^2+1, and $4\alpha+1$, then will always the least value of x be of the form $4\alpha+1$, and y of the form 4α. For $y=m=2\beta$; and β is necessarily an even number when n is of the form $4\alpha+1$. If we subtract 1 from $x=am+1$, the remainder am shall have $2d$ divisors, and we shall have d different ways of obtaining the product am; that is, we shall have so many different square factors of n, each of which will give the least values of x and y.

For instance, in how many different ways can we obtain the least values of x, and y, in the equation $x^2 - 13y^2 = 1$?

*Table containing the least square factor by which each complex must be multiplied to obtain a simple number.**

C. N.	Sq. fact.	C. N.	Sq. fact.	C. N.	Sq. fact.	C. N.	Sq. fact.
13	5^2	59	3^2	94	151^2	127	419775^2
19	3^2	61	3805^2	97	569^2	128	51^2
21	2^2	67	27^2	103	47^2	129	14^2
22	3^2	69	13^2	106	389^2	130	5^2
28	3^2	70	3^2	107	3^2	131	9^2
29	13^2	71	7^2	108	5^2	133	261^2
31	7^2	73	125^2	109	851325^2	134	33^2
41	5^2	74	5^2	111	2^2	135	3^2
43	9^2	75	1^2	112	2^2	137	149^2
44	3^2	76	39^2	113	73^2	139	747^2
45	3^2	77	4^2	114	3^2	149	9305^2
46	23^2	85	41^2	115	7^2	151	3383^2
52	5^2	86	11^2	116	13^2	153	8^2
53	25^2	88	3^2	117	5^2	154	22^2
54	3^2	89	53^2	118	51^2	155	2^2
55	2^2	91	11^2	124	273^2	157	315645^2
57	2^2	92	5^2	125	61^2	158	7^2
58	13^2	93	14^2	126	40^2	. .	. .

Having already found $13\times25=18^2+1$, we inferred $a=18$, $m=36$, $am=648$, whose divisors are 1, 2, 3, 4, 6, 8, 9, 12, 18, 24, 27, 36, 54, 72, 81, 108, 162, 216, 324, 648. Consequently, we ought to obtain 10 different factors of 13 which will, each of them, give the least values of x, and y. These factors are, 10^2, 15^2, 20^2, 30^2, 45^2, 60^2, 90^2, 180^2, $\left(\frac{15}{2}\right)^2$ and $\left(\frac{20}{9}\right)^2$.

I shall say no more upon this new theory, fecund as it is in the resolution of indeterminate problems of all degrees, except the first; leaving it for others to bring it to its highest degree of perfection, if they think it worthy of their attention.

Troy Ladies' Seminary, March 20th, 1849.

* Each column marked *C. N.*, contains the complex numbers, and the column marked *Sq. fact.*, their square factors. Every number not found in this table, up to 158, is a simple number.

ART. VI.—*Review of M. Tuomey's Final Report on the Geological Survey of South Carolina*, presented to the Boston So. Nat. History, May 2d, by THOMAS S. BEUVÉ.

THE State of North Carolina has the distinguished merit of being the first among the governments of the world, to authorize at its own expense, a full survey of its territory for the purpose of developing its resources, and enlarging the boundaries of human knowledge.

Since this most worthy act on the part of her government, her sister confederacies have one after another followed her example; and the result is that we as a people have a degree of information in relation to our resources, which could have been reached in no other way, and which is of the utmost importance to our progress, while the scientific world at large has been led to rejoice in the acquisition of a vast amount of knowledge of which it would otherwise have long remained ignorant.

The State of South Carolina was the second to move in this great work. By order of her legislature, a report upon a geological and mineralogical survey was made by Mr. Lardner Vanuxem as long ago as 1826, and a collection of the minerals of the state deposited in the cabinet of South Carolina College. In 1842 this state authorized an agricultural survey. The work was entrusted to Mr. Edmund Ruffin of Virginia, who conducted it with great ability, but who resigned his office at the close of the first year, making a valuable report of his labors. M. Tuomey, the author of the work now under consideration, succeeded him in the survey, and upon the renewal of his commission in 1844, it being found difficult to separate an agricultural from a geological survey, he was directed by the government to make a report both upon the geology and agriculture of the state, and this he has done in the volume before us.

INTRODUCTION.—As an introduction to the subject of the work, we have quite an interesting treatise on the science of geology, embracing a general description of the formations of the earth's surface, stratified and unstratified, with remarks upon the relation of the igneous and metamorphic rocks; upon metallic veins; and upon the phenomena of volcanoes and earthquakes. We have also a chapter devoted to palæontology, or the knowledge of animal remains, and to fossil botany. The characters of the classes of the animal and vegetable kingdoms are given, and some account of the fossil remains of the various orders and genera, with their geological distribution. To this succeeds a chapter upon the fossiliferous rocks and the succession of organic remains. Figures illustrate the facts stated in this part of the

work, and a table is included showing the order of superposition of the fossiliferous strata with the localities of the characteristic deposits in Europe and America. It would perhaps be difficult to find even in double the number of pages elsewhere, a better abstract of geological knowledge than that presented to us in this introduction, and we think the author has done wisely in appending to his work so much matter of a general scientific character.

REPORT ON THE GEOLOGY OF THE STATE.—The report on the geology of the state, commences with an account of the unstratified rocks, found in South Carolina, exclusively in the upper or northwestern districts. Although this section of the state is known as the granite region, yet true granite is found over but a small portion of the surface. It is seen perhaps in a more continuous range than elsewhere along the line of the tertiary deposits, between the Savannah river and the Congaree below Columbia, separating by an anticlinal axis those strata, which dip south, from the clay slates which have a northern inclination. Granite also appears at the surface to some extent in the counties of Newberry and Lancaster. Nowhere does it rise, however, to any great elevation. In some localities the rock has disintegrated, and masses cover the surface of the ground, which from their form and detached position are often taken for transported boulders.

M. Tuomey accounts for them as follows:

"The rock originally presented a jointed structure, the seams dividing it by their intersection into cubical blocks of various sizes. Disintegration commences at the angles, which being the points of least resistance, are removed by exfoliation, or converted into a slightly cohering mass, that finally becomes a loose earth, enclosing the rounded pieces of rock. This earth is frequently removed from the crevices, and the globular masses remain standing alone, or piled upon each other, as they are often seen. It is in this manner that all the rounded masses of granite in the state have been formed, which can always be distinguished from transported rocks by their identity with the rocks with which they are associated."

A coarse feldspathic granite rises into quite a conspicuous hill in Newberry district, lifting the slates which rest upon it, and giving them a northern and southern dip. This passes at some distance into a fine-grained rock which affords an excellent building material.

The mineral contents of the granite are but few. Auriferous veins are found in it which have been worked, and there exist some beds of porcelain clay derived from its disintegration.

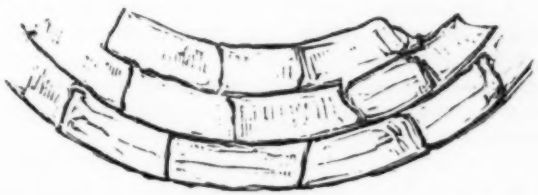
Trap and other intrusive rocks.—An extensive series of trap dikes, which extend from Virginia to Alabama, cross the north-

western section of this state, and this rock composes a considerable portion of the surface of some districts. Generally this, with the associated rocks, have become so much disintegrated as to make the boundary of the dikes obscure; and our author states that he did not meet with a single instance where anything like an escarpment was presented. The direction of the dikes is uniformly between 15° and 35° east of north, and they are rarely inclined much from the vertical.

In Chester district the trap is more developed than elsewhere, covering over a large portion of its surface, and veins of porphyritic feldspar, quartz and graphic granite, intersect it.

The dikes of intrusive rock are not all trap throughout this region. Some are of syenite, others of hornblende rock and of eurite. One of the syenitic veins in York district is intersected by veins of quartz which have been worked for gold. Evidence of the igneous nature of all these rocks is seen in various localities. By their junction with the clay slates of Edgefield, the latter are changed to porphyry, and in Chesterfield the new red sandstone is blackened and otherwise altered, so as to resemble overburnt brick.

In Abbeville district, at a locality on Little river, the trap presents a remarkable structure on its surface, being divided by concentric joints, which are crossed by others nearly coincident with the radii of the curves. This is illustrated by a cut as follows:



The trap rocks of the state have not been found to contain any minerals of interest.

STRATIFIED METAMORPHIC ROCKS.—*Gneiss.*—The non-fossiliferous series of stratified rocks present themselves at the surface over a large portion of the primary region, and of these gneiss is by far the best developed. Of the prevalence of this rock Mr. Tuomey remarks, that "although its continuity is often interrupted by the protrusion of the underlying granite, or the alternation of beds of other rock, and may be covered by patches of the overlying slates, yet it is seen forming a vast plain that extends from the mountains to the middle of the state, forming, with a few exceptions, all the obstructions to the rivers. The strike being at right angles with the courses of the streams that drain the Atlantic slope, a series of falls is produced by the out-

cropping edges of the rock, that extends from its southern limit to the mountains."

The outcropping edges of this rock, it is stated may be traced across the state from the Savannah to the Broad river by parallel ranges of natural dams which they form in the rivers, and over which the water flows, forming picturesque cascades of from ten to eighty feet in height. These phenomena Mr. Tuomey thinks are due to the result of the alternation of more and less destructible beds, the former of which have been washed away, leaving the latter projecting; rather than to a series of uplifts. The strike of these rocks is northeast and southwest, and their dip very nearly that of the Atlantic slope, excepting in a few instances at the southern extremity, where they have been elevated so as to dip in an opposite direction.

Hornblende slate.—This rock alternates with the gneiss in some localities and passes into it. Its extent is limited compared with the gneiss in mica slate.

Mica slate.—Mica slate alternates with both hornblende slate and gneiss. In the extreme northwest of the state, it is the prevailing surface rock of the rounded hills of that region. It passes into talco-micaceous and talcose slates by the substitution of talc for mica. These latter rocks are found only in the gold regions of the state, and in a belt in York and Spartanburg districts that contains magnetic iron ore.

Clay slates.—An extensive deposit of these slates occurs along the northern boundary of the tertiary, from the Savannah river nearly across the state, finally disappearing at the north under the new red sandstone.

Limestone.—Beds of limestone are found both in the gneiss and mica slate, and are quarried to some extent for agricultural and architectural purposes.

Quartz rock.—The rock so designated is a stratified deposit, and differs from the common massive quartz in its granular structure, though it is sometimes compact and resembles the common variety. It is associated with the mica and talcose slates and passes into them. It seems, says Mr. Tuomey, to be the result of the gradual disappearance of the matter forming the micaceous or talcose portion of the rock in which it occurs, and the introduction of a proportionably large amount of siliceous or arenaceous matter during its deposition. One of the varieties of this rock is the itacolumite, or flexible quartz. This variety is found at some localities in this state, and also in the neighboring states of North Carolina and Georgia. It is known as the repository of the diamond both in Brazil and the East. None of these gems have as yet been found in South Carolina, but as our author remarks, thousands may have escaped with the refuse gravel at the gold mines. Both in North Carolina and Georgia

diamonds have been discovered at the gold workings in this itacolumite formation.

Iron ores.—The magnetic oxyd, the specular oxyd, and the hydrous peroxyd of iron, are all found in the talcose and mica slates of some of the districts. The ore Mr. Tuomey thinks cotemporaneous with the slates, being frequently so intermingled with them, as to prevent their being readily distinguished one from the other. In examining one of the beds of specular iron, he comes to the conclusion that it was originally sulphuret of iron, and in connection makes the following remarks, which are worthy of notice.

"It is not a little curious that pyrites will resist decomposition when placed under water, while, if it be exposed to the atmosphere, it is readily acted upon and reduced to an oxyd. Nearly every gold mine in the state offers examples in illustration of this fact. For wherever oxyd of iron is found mingled with the ores, when water is reached, it is invariably found in the form of iron pyrites.

"We have first the sulphuret, or iron pyrites, which by decomposition becomes probably the protoxyd, a portion of which combines with another atom of oxygen, and forms peroxyd, the mixture of the two now existing together, producing the magnetic oxyd. The remaining protoxyd is converted into peroxyd, and the whole is now the specular oxyd or red ore, which we find towards the surface. And when during this change water enters into combination with the ore, we have the hydrous peroxyd or brown hematite ore. Every step in this progress may be observed at the furnace bed, on People's creek."

M. Tuomey states that, with a single exception, he nowhere observed iron ore in a true vein. Here the ore was fibrous hematite, and was traced by him for miles.

Gold.—The gold formation, the circumstances under which gold is found, the mines which are explored, and the methods adopted for working the ores, receive from our author particular attention. We must, however, be brief in our notice of this as well as other portions of the work.

After stating that the gold formation of the United States is confined to a band of schistose rocks extending from the Rappahannock in Virginia to the Coosa river in Alabama, Mr. Tuomey remarks that these rocks in South Carolina, as well as in the neighboring states, seldom exceed a breadth of sixty or eighty miles, and that the gold is found at times in veins of granite, syenite, gneiss, hornblende and mica slates, as well as in the talcose rocks, which have been considered the only gold bearing rocks. He speaks of two classes of mines which are explored; the vein mines, where the metal occurs in the solid rock, and the deposit or branch mines, consisting of beds of gravel and

pebbles of quartz, which occur in low places, in valleys and along the beds of streams. These streams, it is stated, can have had no agency in their formation, as no cause now in operation would account for the wide spread extent of these deposits, or for the rounding and polishing of the pebbles contained in them. Some of the branch mines, however, are mentioned as having had a later origin than those referred to, in which the quartz pebbles are angular and mixed with detritus of the adjoining hills. The gold of these can generally be traced to its original source in the rock, and thus most of the vein mines of the state have been discovered.

From the notices of the different mines it appears that there is generally but poor management in the working of them. Speaking of Brewer's mine, one of the principal of them, upon which about two hundred men are employed, Mr. Tuomey writes, "when I first saw this mine, open-cast excavations in several places were commenced, and in some spots prosecuted to the depth of fifty feet. When I revisited the place, after an interval of two years, it was scarcely possible to recognize it as the same mine. Had a detachment from an enemy been sent to destroy the mine, I cannot imagine how they could have executed their task more completely. * * * The whole grows out of the system of letting prescribed by the owners; and truly 'killing the goose to get the golden eggs,' seems here scarcely a fable.

"A portion of the mine, equal to about twelve square feet of the surface, is let to a company numbering from three to six persons, who work as they think proper, and abandon it when they please. It requires no argument to show that where twenty or thirty such companies are working in this independent manner, there can be little system and less mining, in the proper sense of the term. No grinding apparatus has been used to any extent—the soft portion of the gangue alone being washed for the precious metal; and even that is excavated in the most reckless and unworkmanlike manner: and in washing, the worst form of the common rocker is the only instrument used. In a common deposit mine, where the auriferous bed is only a few feet thick, the loss from this mode of working would be very considerable; but where a mine is worked to the depth of fifty or sixty feet, it must be incalculable."

We have now passed over that portion of the work which treats of the ancient primary deposits of the state, and proceed to notice what is said of those of a later period.

Palæozoic rocks.—In a locality on Thompson's creek, Mr. Tuomey observed strata of highly inclined rocks, which he was disposed to refer to this period. He found no fossils, however, to corroborate this idea.

OLDER SECONDARY ROCKS.—*New Red Sandstone.*—This rock, which is found at intervals from Massachusetts south, finally terminates in South Carolina, four or five miles from the northern boundary, overlying in this State the clay slates unconformably. Trap dikes penetrate it, and the sandstone is much altered by it, sometimes so as to resemble porphyry, having crystals of feldspar imbedded in a black gangue. Veins of carbonate of lime are also found in the sandstone.

UPPER SECONDARY OR CRETACEOUS ROCKS.—The cretaceous formation of South Carolina next comes under the notice of our author, for as he remarks, "there is a wide gap in the geological series of South Carolina, extending from the metamorphic rocks to the upper secondary, and unfortunately among the missing rocks, we find the carboniferous system, with its coal measures."

The cretaceous deposits are described as appearing upon the surface in Horby district, where the strata dip beneath the sands of the coast and are covered by tertiary beds, also at a number of other localities in this and the neighboring districts. They are composed generally of marl, marl stone, and shales. It is remarkable that the green sand so characteristic of this formation in New Jersey and Delaware, is absent in the beds of the same age in South Carolina, and still appears again in deposits of a later period.

The fossils of these deposits are not numerous, the following list comprising all yet known.

Carcharodon,	(species?)	Pectunculus hamula,	Mort.
Lamna,	(species?)	Anomia argentifera,	"
Ammonites placenta,	Dekay.	Trigonia thoracica,	
Belemnites vertebroides,	Morton.	" crenulata.	
Natica petrosa,	"	Cardium altum.	
Ostrea cretacea,	"	" (species?)	
Exogyra costata,	Say.	Crassatella vadosa,	Mort.
Plagiostoma dumosum,	Mort.	Hamulus onyx,	Mort.
Cucullæa ovata.			

TERTIARY SERIES.—The tertiary deposits of South Carolina are distinguished from those of the cretaceous, not less in their mineralogical than in other characters. Instead of the dark marls and marl stone which prevail in the latter, we find in the tertiary deposits, thick strata of limestone, highly calcareous marl, with beds of loose sand, clay and gravel. From the coast, they cover the surface of the slate inland, with the exception of the small patches of cretaceous rocks, for a distance of more than one hundred miles, occupying about two-thirds its whole extent. Along a line from the Savannah near Hamburg, to Thompson's creek, where it enters the slate from North Carolina, is found their boundary, and they are here observed resting immediately upon

the granite, the gneiss, and the clay slates of this region. Along this line too, are found the first falls in ascending the rivers caused by the tertiary which come in contact with the harder rocks, being washed away.

One striking fact mentioned in relation to this boundary is the change observable in the botanical features of the country in crossing it. The Pinus americanus here finds its inland limit, and the common grass of the pine woods of the genus Aristida, here gives place to the brown grass (Andropogon) of the higher lands.

Eocene.—The eocene deposits are represented as occupying a deep depression of the cretaceous strata, which latter are observed only in the northeastern section of the state where they sink beneath the tertiary rocks, not to appear again at the surface; though undoubtedly underlying the vast beds of a later period, which in this region are seen to rest upon them.

The eocene strata Mr. Tuomey describes as occurring in three well marked groups. The Burr-stone, the Santee beds, and the Ashley and Cooper beds.

The Burr-stone formation, the oldest of these eocene strata, is extensively developed at numerous localities, and is made up of sandstone, clay, beds of gravel and sand, and silicified shell or burr-stone; which last gives its name to the whole group. The relative position of these deposits and the calcareous rocks of the Charleston basin, has been a matter of some question, but Mr. Tuomey has settled the point, having traced the burr-stone beds, under those of the calcareous rocks.

The fossils of this group are numerous, and a list is given of 53 species Gasteropoda, 30 species Lamellibranchiata, and three or four undescribed species of corals are mentioned as occurring, together with leaves of exogenous plants of the genera Quercus, Fagus and Salix, and some remains of crustacea.

The predominance of Gasteropods among these fossils indicates, says Mr. Tuomey, the littoral character of the formation, and he draws the inference from this fact and from the existence of land shells and remains of plants, among the fossils, "that the whole group was deposited on the coast of the eocene sea." This formation it will be seen by reference to the map, has its principal development at the surface in the districts of Orangeburg and Lexington.

The Santee beds or Calcareous Strata of the Charleston basin, occupy a large area of the surface of the state south of the Santee, and have been called *the Carolina bed*, because of their great development in the state. They outcrop at numerous localities along the right bank of the Santee, also along the southern line of the burr-stone between the Santee and the Savannah, and on the Savannah. These deposits consist of beds of thick white limestone, marl and green-sand.

The list of fossils collected show the following result: 3 species of Cephalopoda, 8 of Gasteropoda, 8 of Pteropoda, 20 of Lamellibranchiata, 17 of Polyparia, maxilla, teeth, and vertebræ of the Zeuglodon, teeth of an undetermined Saurian, teeth of 8 genera of fishes. Mr. Tuomey remarks, that "this list presents a very different result from that obtained from the fossils of the burr-stone; for besides the introduction of the classes Cephalopoda, and Pteropoda, there is a great numerical falling off in the Gasteropoda; and yet the occurrence of oysters in these beds, and of corals in some of them, would indicate a sea of no great depth at the time of their deposition."

Beds of the Ashley and Cooper rivers.—These are the newest deposits of the eocene in South Carolina, and they are composed principally of dark marls, which are distinguished from the marl of the previously described beds, not less by the difference in their organic remains, than in that of color. Localities of these deposits are described, not only on the Ashley and Cooper rivers, but at numerous other places.

The remains of cartilaginous fishes are very abundant in their beds, and Mr. Tuomey referring to a locality at Bee's ferry on the Ashley, remarks, "It would seem as if about the close of the eocene period, these voracious monsters, conscious of their approaching end, had congregated here to die, and it is no exaggeration to say, that more than a bushel of fishes' teeth had been collected here within a few years. I have visited the locality several times, and never without finding a large number of specimens."

The fossils mentioned as occurring in these beds are the following:—

Mammalia.—Equus,	(teeth.)	Palæotheria,	(teeth.)
Tapir,	"	Manatus,	(ribs.)
Zeuglodon, (head and vertebræ.)			
Reptilia.—Chelonia.			
Pisces.—Pristis,	1 species.	Hemipristis,	2 species.
Ptychodus,	1 "	Glyphis,	1 "
Myliobates,	5 "	Otodus,	4 "
Carcharodon,	10 "	Oxyrhina,	9 "
Corax,	4 "	Lamna,	9 "
Galeocerdo,	6 "	Cælorhyncus,	1 "
Mollusca.—Cephalopoda,	1 species.		
Gasteropoda,	7 "		
Lamellibranchiata,	12 "		

Also of Cirripedia, 3 species, and of Corals 1 species. Of these deposits, Mr. Tuomey remarks, "that the existence of the remains of terrestrial mammalia shows that they could not have been deposited at a great distance from land."

With the account of the eocene strata we have a list of the fossils common to both the burr-stone and the strata of Claiborne, Alabama, which shows conclusively that they are equivalent. This list embraces no less than 58 species.

Fossils common to the Cretaceous and Eocene formations.— The following are given as common to both these periods:— Ammonites placenta, Terebratula Harlani, Plagiostoma gregale, Gryphæa mutabilis, Ostrea panda, Trigonia thoracica? and also two species at least of Echinoderms.

The announcement in this list by Mr. Tuomey, of ammonites common to both the cretaceous and tertiary formations, will not fail to surprise our palæontological readers, as it has been hitherto supposed that this genus ceased to live before the period of the tertiary deposits. As strong evidence of the existence of this fossil in our tertiary will be required, before its presence there will be admitted, we give Mr. Tuomey's account of the discovery.

"In 1846, I happened to be in Wilmington during the progress of an excavation in the conglomerate of that place. The excavation was made on the side of the hill on which the city stands, and in the upper part of the conglomerate, where it was in contact with the miocene. I found the surface perforated with lithodomous shells of miocene species, showing that it was the bed of the eocene ocean at the time that the latter formation was quietly deposited in it.

"I was not a little surprised to find here a Trigonia, at least related to *T. thoracica*, Mort., if not identical with it, together with several well characterized casts of *Ammonites placenta*, Dekay, a fossil found in the cretaceous beds of Delaware, and in those of the Peedee, South Carolina.

"Seeing that this bed is a conglomerate, I set myself to examine the probability of these fossils being washed from the cretaceous beds, higher up the river, upon which it rests. The conglomerate is composed for the most part of rolled calcareous pebbles, agreeing with the mass in which they are embedded, and it is well known that lithologically, the cretaceous beds of North and South Carolina are entirely different, and hence I could not fail to detect any thing brought from that formation. The casts are composed of the white limestone; and the casts of eocene fossils, with which they are associated, are so perfect, that I was forced to the conclusion, that the molluscs belonging to these shells, lived and died where they are entombed."

The fact that ammonites were found only in a bed of conglomerate, and that Mr. Tuomey himself questioned as to the probability of their having been washed from the cretaceous beds, notwithstanding his conclusion to the contrary, will leave some doubt on the minds of many on this point. Considering however, that there are other fossil species, as the Ostrea panda and the Gryphæa mutabilis, which were certainly contemporaneous with the Ammonites placenta in the cretaceous period, and

which are now unquestionably found in the eocene tertiary of South Carolina, we see no reason to doubt the conclusion that Mr. Tuomey came to in regard to the Ammonites placenta, found by him at Wilmington, notwithstanding the fact that no Ammonite had previously been found either in the tertiary of this country or in that of Europe. If one species survived the change, many might, and probably did.

PLIOCENE.—Scattered over the state, at various localities, particularly in Darlington and Sumter districts, are marl deposits of an age later than the eocene, and which, following Mr. Lyell's classification, Mr. Tuomey includes in the pliocene; as they are found to contain a much greater proportion of recent shells than the miocene beds of Virginia and Maryland. In the districts named, the pliocene rests immediately on the cretaceous marls.

Fossils of these beds.

MAMMALIA.—Mastodon, Cervus.

PISCES.—Carcharodon. Galeocerdo. Saurocephalus.
Lamna. Hemipristis. Cœlorhynchus.

MOLLUSCA.—Brachiopoda, 1 species.
Gasteropoda, 78 " of which 39 are recent.
Lamellibranchiata, 109 " " 47 " "

Also of CIRRIPEDIA, 2 species, of which 1 is recent.

POST-PLIOCENE.—The post-pliocene deposits of South Carolina occupy the line of the coast for about ten miles inland, resting upon the pliocene in Horby and Georgetown districts, and south of this upon the eocene rocks. They are composed of beds of sand, clay and mud, their whole thickness being about sixty feet.

MAMMALIA.—Mr. Tuomey found some fragments of bones in the post-pliocene, which he concluded to belong to the Megatherium.

PISCES.—Carcharias, Lamna.
Myliobates, Diodon.
Trichiurus.

MOLLUSCA.—Pteropoda, 1 species.
Gasteropoda, 39 "
Lamellibranchiata, 65 "

Also of Cirripedia, 1 species, Echinodermata 4 species, and Polyparia 2 species.

ALLUVIUM.—This in turn is noticed, and the question considered here whether the southern coast is subsiding as has been alledged. Our author concludes that it is not, and shows the evidence brought in favor of such a view to be due to other causes.

Recapitulation.—Mr. Tuomey presents the following as the results of his investigations in the tertiary deposits.

"1st. That they are situated in a vast depression in the cretaceous rocks, which however are only visible on the east and northeast.

"2d. That the eocene consists of three well defined groups: 1. *The burr-stone formation*, composed of thick beds of sand, gravel, grit, clay, and burr-stone, amounting to at least 400 feet in thickness—and underlying the calcareous beds. Its upper portions are characterized by beds abounding in silicified shells, for the most part identical with the Claiborne fossils. As these are littoral shells, they probably occupied the coast while the Santee beds were forming in deep water. The materials of which this formation is composed, are the ruins of the granitic and metamorphic rocks of the upper districts, which may often be traced to their origin. 2. *The Santee beds*, consisting of thick beds of white limestone, marl and green sand. These are best seen on the Santee where, interstratified with the green sand, they dip gently towards the south. The coralline marl of Eutaw is found near the upper edge of these beds. 3. *The Ashley and Cooper beds*, which are the newest eocene beds of the state. The marl of these is characterized by its dark grey color and granular texture, while the remains of fishes and mammalia give its fossil remains a peculiar character, and leave no doubt of the position assigned it, at the top of the eocene series. These together with the Santee beds, must amount, at least to a thickness of six or seven hundred feet.

"3d. That although these strata contain, throughout, characteristic eocene fossils, yet they also enclose some cretaceous forms.

"4th. That the middle tertiary of the state, composed of beds of sand and marl, highly fossiliferous, is scattered, like similar beds in other places, over the eocene and cretaceous formations, in isolated patches. That the proportion of recent species increases towards the south; and that the extinction of species seems to proceed in that direction, as is proved by the fact that the recent forms, which are also fossil, belong to a more southern fauna—there being but one or two exceptions.

"5th. That in South Carolina, the proportion of recent species in this formation amounts to forty per cent. I have therefore referred it to the older pliocene.

"6th. That the post-pliocene is confined to a belt along the coast of about eight or nine miles in breadth. The fossils are nearly all referable to recent species now inhabiting the coast: a few, however, belong to the fauna of Florida and the West Indies. An elevation of the coast has taken place since the deposition of these beds, which it is probable has given the rivers of the Atlantic slope a western tendency.

"7th. That the submerged stumps of trees, found below the level of high tide along the coast, are not the result of subsidence, properly so called, but must be referred to the encroachment of the sea upon the land, and to the peculiar character of the deposits in which they grew.

"That the almost entire absence of fluviatile shells in the recent and tertiary deposits, is mainly due to two facts: 1. That there is a considerable space between the line of brackish and salt water, where neither fluviatile nor marine forms can exist. 2. That the streams have not transporting power sufficient to bring down fresh water shells. So long as these circumstances exist there can be no mixture of fluviatile and marine shells."

Practical Geology.—With the tertiary, of course, the portion of the work devoted to descriptive geology ends. The remainder of the volume, excepting the appendix, is devoted to *practical* or *economical* geology. Under this head we have presented by the author an interesting and valuable treatise upon soils in general, their classification, physical properties and chemical composition:—Upon the composition of cultivated plants:—manures, animal, vegetable and mineral, with their effects:—rotation of crops and draining:—lime burning:—metallurgy:—the manufacture of iron:—the extraction of gold from its ores:—and upon the materials used in the arts found in the state, &c. &c. The greater portion of this we pass over without particular comment; not that it is of less interest than other portions of the work, but because it relates to matters not exclusively concerning the geology of South Carolina. We will touch, however, upon one or two points.

Of the extraction of gold from its ores, Mr. Tuomey gives a detailed account, hoping thereby to call the attention of inventors of machinery to the very rude processes by which it is effected, in order that some improvement may be made in the machinery used. He therefore particularly describes all the means adopted at the mines for the separation of the metal, and gives figures of all the various machines used in the state for the purpose. We mention this fact, because our article may meet the eye of some reader, who will learn by it what is required, only to supply the want.

Of the metallic substances found in the state, besides gold and the oxyds of iron, of which notices have been taken, the following are enumerated: *manganese, lead, copper, bismuth, graphite, oxyd of titanium, sulphuret of iron.*

A number of mineral springs are mentioned as occurring in the upper districts, some of which are visited for their medical virtues.

Appendix.—In the Appendix, a catalogue of the fauna of South Carolina is given, prepared by Dr. Lewis R. Gibbes of the South Carolina College.

In concluding a notice of this work, we will remark, that we think a good geographical map should have accompanied it. It is indeed absolutely necessary in order that the text be fully understood, that the reader have one before him. This want would not be felt as it is, if the localities cited were given on the geological map, which is not the case, excepting so far as relates to the districts.

We cannot refrain too from expressing our strong regret, that the figures of the fossils of the state were not published, as was intended by Mr. Tuomey. It seems from a postscript to the preface, that while the report was passing through the press, he was informed, "that the committee on publication had decided that the plates containing the figures *were not essential*," and they were therefore omitted.

We will not however complain of this as showing any want of liberality on the part of the state. She has done well in presenting to the world what she has, and in behalf of that world, we would thank her, and rejoice in what is received from her hands.

To Mr. Tuomey we extend our congratulations, that his labors are now brought to a successful close. We believe he will have constantly increasing evidence that he has not labored in vain.

ART. VII.—*Some Observations upon Emulsine and its Composition;* by B. W. BULL, Hartford, Conn.

THE following investigations were made in the summer of 1848, at the suggestion of Prof. von Liebig, in the hope of eliciting some farther information in relation to the constitution and properties of this substance. The method at first employed in preparing emulsine was that of Ortloff, as recommended by him in the Archiv. der Pharmacie, vol. 48, page 12,* which is the following: "The sweet almond powder already freed from oil by pressure, is to be stirred with about three times its weight of water, and the mixture, placed in a wide mouthed loosely covered glass vessel, is to be exposed to a temperature of 15° to 20° R., during five or six days, till all the albumen? is destroyed by the consequent fermentation. The fluid is then to be filtered off, and the emulsine precipitated by adding strong alcohol in sufficient quantity, and subsequently dried at a temperature not exceeding 30° R." It is described as a "reddish gray or reddish yellow mass, gum-like and brittle; in small pieces, horny, transparent, with a glossy lustre externally and internally dull."

* For an abstract of this paper, see Berzelius Jahres-Bericht, 27th volume, page 396, German edition.

Ortloff further mentions that a precipitate in a solution of emulsine is a proof that all the alumina was not decomposed, in consequence of the period allowed for fermentation having been too short; that freshly precipitated emulsine redissolves entirely in water, and after being dried, redissolves, leaving a residue consisting of phosphates of lime and magnesia, while the solution contains only traces of inorganic matter. Among other characteristics of emulsine according to the above chemist, is that of its being free from sulphur, a conclusion based upon the fact that treated with caustic potassa it does not form sulphuret of potassium and continues to precipitate lead salts white; a result quite at variance with those which I have obtained by a similar treatment.

A couple of trials in which the above method was followed, did not afford me favorable results. The mixture became quite sour, but even after the lapse of nine days at the given temperature, a filtered portion continued to give a strong precipitate with acid, and on the addition of alcohol, the substance thrown down did not redissolve by the addition of water. After numerous attempts, I have found it preferable to prepare emulsine as follows. The finely powdered sweet almonds, already freed from oil by cold pressure, are made into an emulsion with as small a quantity of water as possible. Three times their weight of water is sufficient, and with this amount they can be treated twice, using two-thirds of the water at the first, and the remainder at the second treatment. It should be strained through a linen cloth and the residue both times strongly expressed. The resulting fluid is afterwards to be placed in a suitable vessel and exposed to a temperature of 20° to 25° C. Within twelve hours, if untouched, it separates in two parts. A creamy coagulum, forming perhaps one-fifth of the whole, rises to the top. It is generally of a yellowish white color, though sometimes tinged with pink on the surface. The transparent watery fluid undeneath is light yellow, quite limpid, and after standing two to three days, gives no precipitate with acetic acid. By adding alcohol, a precipitate is obtained which entirely redissolves upon the addition of water. If the vessel has not been moved during the process of separation, the coagulum assumes so firm a consistence that the watery portion can be almost entirely removed by means of a small syphon, without admixture with the former, in which case it filters very readily. As soon as the separation has taken place, the liquid is ready to be filtered off and precipitated by alcohol. For reasons which will be given below, I do not think it at all necessary for the preparation of pure emulsine that the fluid shall have ceased to be affected by acetic acid, or that the substance thrown down by this reagent should be removed by the addition of it in excess. As I wished however to examine the acetic acid precipitate, the

liquid was generally filtered from the coagulum as soon as the separation had ensued, and to the filtrate acetic acid was added till no farther precipitate was produced. From the liquid filtered from the precipitate, the emulsine was then thrown down by alcohol of 85 per cent., a double volume of which I have found necessary. In the alcoholic fluid a small quantity still remains in solution, and a farther addition of alcohol is necessary if the whole amount is desired. For this reason as small a quantity of water as possible has been recommended in preparing the emulsion.

Obtained in this way, and washed with alcohol of 85 per cent. upon a filter with subsequent drying in the air, I have found emulsine very similar in appearance to that described by Mr. Ortloff, being a transparent gum-like brittle substance of a dark reddish brown color, without odor, and not possessing any positive taste. It dissolves with difficulty after maceration in water or by rubbing in a mortar, leaving behind a residue totally insoluble in water, and containing besides phosphates of magnesia and traces of lime, a large amount of organic matter. This insoluble residue, after being thoroughly washed with distilled water, still gives distinctly the characteristic reaction of emulsine with amygdaline. The proportion of organic matter which it contains is very variable. Four experiments gave me as follows:

	No. 1.	No. 2.	No. 3.	No. 4.
Organic matter,	56	69·45	59·48	80·27
Ash,	44	30·55	40·52	19·73
	100	100·00	100·00	100·00

The solution is opalescent, and possesses in the highest degree the property of decomposing amygdaline into bitter almond oil and hydrochloric acid.

Dried in vacuo over sulphuric acid, it presents very nearly the same appearance. Its color however is not generally as dark, sometimes inclining to a brownish yellow, and at others to a brownish red. When dried with free access of air, it absorbs moisture with avidity while the alcohol is escaping; if the atmosphere is at all damp, and if left upon the filter, it penetrates the pores of the paper in this state, to which it adheres with great tenacity when dry.

The dark colored appearance of emulsine as obtained in this way, so very different, not only from the almonds themselves, but also from that of the most freshly precipitated substance, which is always white, leads to the conclusion, that while drying, it undergoes some change from the action of the air, which, though possibly not affecting its ultimate composition, still would render the analysis of a less colored product more satisfactory.

The use of a few precautions has enabled me to obtain emulsine perfectly white and consequently differing in appearance entirely from that described by Robiquet and Ortloff, who both agree in ascribing to it the color mentioned above.

If the freshly precipitated substance is at first washed out with strong alcohol till all soluble matter is removed, afterwards with absolute alcohol till deprived of every trace of water, and at last dried upon glass in vacuo over sulphuric acid, it is obtained in snow-white brittle masses, entirely opaque, without lustre and breaking with a dull starchy fracture. It is also more soluble than that prepared in the ordinary manner as at first described. I have not succeeded in all cases in obtaining a white preparation, and have found by experience that the following are requisite for success. It should be prepared in small quantities in order that it may dry as rapidly as possible. The powder remaining after pressure of from one to two pounds of the kernels, is a suitable amount to operate upon. From one pound of the kernels I have generally obtained six grammes emulsine, and this quantity can be conveniently dried under one receiver of ordinary size.

It should previously be freed as much as possible from alcohol by pressure between unsized paper, and afterwards placed under the receiver in glass or porcelain vessels, (watch-glasses answer the purpose very well,) in layers of not more than one or two lines in thickness: if thicker, or if from other causes it is not dried by the expiration of twelve hours, it assumes a more or less yellow or reddish tinge. If large quantities are taken, the time requisite for filtering and washing is unavoidably prolonged, and a preparation more or less colored is the result. When dried over sulphuric acid, in a receiver from which the air has not been exhausted, but after having in other respects been treated as above last mentioned, it appears to absorb moisture even then, and becomes upon drying, gum-like transparent and yellow. Still it does not seem to form any definite combination with water, for a portion of this gummy transparent variety upon being reduced to powder and dried over sulphuric acid till a constant weight was obtained, did not suffer any farther diminution in weight by exposure to a temperature of 100° C.

If dark colored emulsine is redissolved in water, separated by filtration from the insoluble portion and re-precipitated by alcohol with subsequent drying *in vacuo*, it becomes snow-white even if not treated with absolute alcohol.

It is generally more or less transparent however, and preserves a glossy lustre externally. But this is not an economical method of obtaining it, as a large amount of the substance employed remains undissolved. Both the white and colored emulsine possess its characteristic property of decomposing amygdaline in the high-

est degree, and apparently to an equal extent. The presence of foreign substances injures this reaction, and even the presence of a small amount of alcohol or acetic acid prevents it altogether.

The property of being precipitated by alcohol does not belong to emulsine in itself, and this method of its preparation and precipitation from the other substances rests upon the phosphates which are held in solution by it, and they have so much affinity for each other, that I have not succeeded in separating emulsine from these inorganic substances without destroying its property of decomposing amygdaline. Emulsine has a decidedly acid reaction. When washed out with alcohol till the latter comes away entirely neutral, the moist emulsine reddens litmus strongly; dried emulsine is also acid when redissolved. To this acid property is owing the presence of the earthy phosphates in the almond emulsion, and to their insolubility in diluted alcohol and simultaneous affinity for emulsine, must be ascribed the cause of the precipitation of the latter by the addition of alcohol. In proof of the preceding remarks, the following may be mentioned. I neutralized an emulsion of almonds by means of a careful addition of lime water, which precipitated the phosphates entirely. The filtrate did not contain a trace of phosphoric acid, reacted in a marked manner with amygdaline, but was not precipitated by alcohol. Ammonia acts in the same way. The liquid becomes cloudy indeed, on the addition of alcohol, but it is not cleared by filtration, and only after several days does a scarcely appreciable precipitate appear. A solution of emulsine neutralized in this way, if left by itself, exposed to the ordinary temperature of summer, commences to decompose in a few days, and assumes a disagreeable odor; the liquid becomes turbid, deposits, but does not again acquire an acid reaction.

Emulsine is not coagulable by heat. A solution of it becomes cloudy at a temperature of 35° to 36° C., at 45° it is quite opaque and milky, and at 85°–90° deposits a snow-white granular substance. When exposed to the heat of a water bath even a number of hours, the filtrate on additional heating still continues to deposit, but if the liquid is carefully heated over a flame to the boiling point and maintained at that temperature a few moments, the filtrate possesses the singular property, upon again being heated to ebullition, of becoming quite opaque, with separation of bulky flocculent masses, which perfectly redissolve upon cooling, and the liquid becomes as clear and limpid as before. The repeated action of heat is followed by the same result; the flocculent matter redissolving perfectly, after being produced several times. The granular precipitate which is formed amounts to about ten per cent. of the emulsine employed. It is perfectly white, easily reduced to a fine light powder, and leaves a neutral ash, amounting in one instance to 48·74 per cent., and in another

to 59·11 do., consisting of phosphate of magnesia with a small amount of lime. The accompanying organic matter contains nitrogen, but no sulphur could be detected by treatment with caustic potassa and lead salts.

It is quite apparent that this is not a coagulation but rather a decomposition, and that emulsine does not possess the property of being coagulated heretofore ascribed to it. The filtrate contains a product of this decomposition which is precipitated by strong alcohol in the form of a white granular substance, amounting to nearly thirty per cent. of the original quantity, and which, when dried, after washing with alcohol and ether, remains in white opaque masses, somewhat tenacious and quite difficult to pulverize. It contains a large amount of earthy phosphates varying in different samples from eighteen to thirty-five per cent. From the following analyses it appears to differ materially from emulsine in its amount of nitrogen, which is in proportion to the carbon as 1 to 12.

I. ·4875 grm. substance containing 81·15 per cent. organic matter, corresponding to ·3956 grm., gave with chromate of lead, carbonic acid ·6265 grm., water ·244 grm.

II. ·4045 grm., as above, corresponding to ·3282 grm., gave with chromate of lead ·519 grm. carbonic acid, and ·199 grm. water.

III. ·423 grm. containing 64·93 per cent. organic substance, corresponding to ·2747 grm., gave with chromate of lead ·4285 grm. carbonic acid, and ·1737 grm. water.

IV. ·4183 grm. as above, corresponding to ·2718 grm., gave with soda lime ·3735 grm. chlorid of platinum and ammonium.

V. ·412 grm. as above, equal to ·2675 organic matter, gave with soda lime ·3555 chlorid of platinum and ammonium, from which the following are calculated,

	1.	2.	3.	
C - -	43·17	43·11	42·48	
H - -	6·85	6·73	7·02	
N - -	8·62	8·34	8·48	mean
O+S -	41·36	41·82	42·02	
	100·00	100·00	100·00	

Neither of the above bodies possesses any power of decomposing amygdaline. This latter is decomposed by acetate of lead into a body containing sulphur and one free from it. The moist precipitate by alcohol was redissolved in water, leaving a small insoluble residue behind. To the solution was added neutral acetate of lead as long as a precipitate was produced. This precipitate was washed out with distilled water and decomposed by passing a stream of sulphureted hydrogen through it while suspended in water. The excess of sulphureted hydrogren was removed

by exposure to gentle heat. The filtrate possessed a strong acid reaction arising in part from phosphoric acid and partly from an organic substance, a product of the decomposition. On concentration it formed a syrupy mass, which was uncrystallizable and decomposed by the action of caustic potassa with evolution of ammonia. The solution gave a reaction of sulphur with lead salts.

The filtrate from the precipitate by acetate of lead, contained a large amount of unprecipitated organic matter. The lead was removed from it by sulphureted hydrogen, and the excess of this latter and the acetic acid, as before by gentle heat. The residue was a neutral gum-like mass, very soluble in water, and forming a jelly with a solution of caustic potassa. This substance contained nitrogen but no sulphur. Another substance ensues by the decomposition of emulsine by boiling, which is not precipitable by alcohol and is about one-quarter of the amount originally employed.

Emulsine is entirely precipitated from its solutions by neutral acetate of lead. The filtrate does not give the slightest reaction with amygdaline, while the lead compound, after being washed and brought in contact with that substance, indicates very perceptibly the formation of bitter almond oil. In this respect my observations agree with those of Ortloff, and give a very simple explanation of the failure which has always attended those who have endeavored to prepare this substance after the method recommended by Robiquet, viz., "by first precipitating all the other organic matter from an almond emulsion by acetate of lead in excess, and then throwing down the emulsine, from the filtrate by means of alcohol." The statement of Robiquet, that emulsine is colored red by tincture of iodine, is not confirmed by my experience. On the contrary, a precipitate of a yellowish brown color is produced. A solution of emulsine exposed to the air at the ordinary summer temperature, begins to decompose in four or five days with evolution of gas. It becomes turbid, precipitates strongly with acetate of lead but not with acetic acid, and for some time does not lose the property of reacting with amygdaline.

The sulphur in emulsine is indicated by treatment with caustic potassa and subsequent addition of lead salts, as also by fusion with saltpetre and soda.

If to a solution of emulsine, neutralized with lime water in order to remove the earthy phosphates and prevent the subsequent presence of phosphoric acid, and afterwards filtered, is added neutral acetate of lead, a bulky precipitate is produced. The precipitate obtained in this way was washed with distilled water and afterwards decomposed by suspending in water and passing through it a stream of sulphureted hydrogen. The resulting liquid, after the acetic acid and sulphureted hydrogen are remov-

ed by evaporation, possesses an acid reaction, and on evaporation leaves a gum-like acid uncrystallizable mass. This substance contains nitrogen and is insoluble in alcohol and ether. It forms insoluble salts with baryta and silver, and a soluble one with magnesia, but could not be obtained in sufficient quantity for analysis. The filtrate from the precipitate by acetate of lead contains a large amount of organic matter, which, when the lead is removed by sulphureted hydrogen, reacts quite neutral and leaves upon evaporation a gum-like mass, which also contains nitrogen.

On one occasion, in the hope of obtaining a larger amount of the above mentioned acid substance, I took a number of grammes of freshly precipitated undried emulsine, thinking in this way to avoid the formation of the insoluble compound left behind when dried emulsine is redissolved, and the consequent loss of material, but quite unexpectedly the resulting solution was not precipitated on the addition of the lead salt. On the contrary, redissolved dried emulsine gave invariably a precipitate with that substance.

The behavior of emulsine towards acetate of lead can only be explained by attributing it to the relation in which it stands to the phosphate, a relation so delicate as to be disturbed or materially altered by merely undergoing a drying process over sulphuric acid. In favor of this opinion is the fact of the increase of inorganic matter in the insoluble portion remaining when dried emulsine has been treated with water, and the corresponding decrease of the same in the solutions showing that redissolved emulsine is unable to retain so large an amount of phosphates in solution as when first precipitated and undried, or in the state in which it exists in an almond emulsion. The per-centage of the phosphates present is very irregular and does not seem to be influenced by chemical proportions at all, but the average results obtained confirm the above statement. The large amount of these salts in the substance at present treated of, is but another instance of their almost universal presence in all organized structures, as well as of the important, though it must be confessed, slightly understood *rôle* which they play in the animal and vegetable economy.

Upon distilling the alcohol from the liquid from which the emulsine had been precipitated, the residue became gradually colored, and at the end of the operation was quite dark. Evaporated upon a water bath, it became a thick syrupy acid mass. Agitated with ether, the latter became quite acid, and upon distilling the ether, a yellow acid liquid remained in the retort, which by a second treatment was obtained nearly pure and colorless. By neutralization with carbonate of zinc and concentration, distinct quadrangular prismatic crystals were obtained, resembling lactate of zinc, but not in sufficient quantity for analysis. In the syrupy

liquid, crystals were observed which were separated from the fluid, washed out with cold water and redissolved with the intention of recrystallizing. A number of attempts, while operating on the amount obtained from small quantities of almonds, did not succeed, but on evaporating the residue from a large amount, several crops of quadrangular prismatic crystals were observed, which were treated with cold water in which they were not easily soluble, afterwards with alcohol which removed a large amount of the coloring matter, and then recrystallized. This was a magnesia salt, and by treatment with animal charcoal and recrystallization did not become sufficiently pure for analysis. It was transformed into a lime salt, by treatment with milk of lime which threw down all the coloring matter with the magnesia. The excess of lime was neutralized by sulphuric acid and the sulphate of lime removed by concentrating the solution and redissolving in alcohol. From the alcoholic solution white acicular crystals, radiating in star shaped groups, were obtained in abundance.

The following analysis shows that the original crystals were lactate of magnesia, and that the substance analyzed was the corresponding lime salt. I. ·6252 grammes gave with oxyd of copper ·7415 grm. carbonic acid and ·269 grm. water.

II. ·569 grm. ignited with sulphuric acid, gave ·345 grm. sulphate of lime giving the following composition.

	Found.	Calculated.
C - - - -	32·34	33·03
H - - - -	4·78	4·59
O - - - -	37·93	36·69
CaO - - - -	24·95	25·69
	100·00	100·00

Corresponding to the formula $C_6 H_5 O_5 CaO$.

The precipitate produced by acetic acid was examined and prepared for analysis, by washing with water and subsequent boiling with alcohol and ether to free it from the accompanying oil. In this state it is a fine light powder of a reddish tint, soluble in alkalies, and in warm concentrated solutions decomposed with evolution of ammonia, insoluble in dilute and partly soluble in concentrated acetic acid and not precipitated from its alkaline solutions by alcohol. It contains nitrogen and sulphur, burns with a smoking flame, and leaves a trifling amount of ash with a neutral reaction. Strong hydrochloric acid dissolves it, forming a fine red liquid, which after a day or two turns to a dark purple. In sulphuric acid, it gelatinizes and turns through red to black with evolution of sulphurous acid.

I. ·274 grm. substance containing 1·59 per cent. ash, equal to ·2697 grm. organic matter, gave with chromate of lead ·5045 grm. carbonic acid and ·167 grm. water.

II. ·5115 grm. as above, corresponding to ·5034 grm., gave with soda-lime 1·266 grm. chlorid of platinum and ammonium.

III. ·4125 grm. ditto, corresponding to ·406 grm., gave 1·083 grm. chlorid of platinum and ammonium.

IV. 1·4428 grm. ditto, corresponding to 1·4199 grm. fused with potassa and saltpetre, gave with chlorid of barium ·058 grm. sulphate of baryta.

The precipitate treated with hydrochloric acid, again ignited and weighed, gave the above result at the second weighing.

V. 2·156 grm. as above, equal to 2·1216 grm., gave with a similar treatment, sulphate of baryta ·086 grm. at the second weighing.

From the above the following results are calculated :

	1.	2.
C	51·020	. .
H	6·870	. .
N	15·800	16·750
O	25·744	. .
I	·566	·565
	100·000	

The proportion of nitrogen to carbon is as one to seven and a half. The per centage of carbon and hydrogen is very nearly that of the legumin from almonds of M. Dumas, but the per centage of nitrogen is smaller, and its reaction with acetic acid is quite different from that ascribed to this latter substance.

A portion of fresh almond powder was macerated with ordinary alcohol at a moderate temperature, the filtrate evaporated to dryness in a water bath and treated with distilled water. A part consisting principally of oily matter remained behind, while the filtrate possessed a sweet taste, and with Trommer's copper test gave indications of the presence of sugar. From the reduction of the copper, which took place at the ordinary temperature within twenty-four hours, the inference was drawn that this substance was present in the form of grape sugar.

With a view of examining the free acid formed during the fermentation, an emulsion prepared as above mentioned, was exposed to a temperature of about 30° a number of days. The separation of the coagulum ensued, which was separated from the liquid by decantation, and the remainder exposed to the continued action of the air and heat. The watery fluid became more acid each day till after standing five or six days, when it began to acquire a disagreeable odor, became turbid, and a white pellicle covered the surface. As the acid reaction at this stage appeared to diminish, the whole was then submitted to distillation. An aromatic liquor came over resembling very much in odor that of rose water, and containing a small amount of alcohol, but not

the slightest trace of acetic acid could be detected even by the delicate test recommended by Bunsen, which consists in evaporating to dryness in contact with caustic potash and arsenious acid. The least trace of acetic acid is revealed by the formation of alcarsin. The distillate was treated with carbonate of baryta in excess, a part of which was dissolved and again distilled. The distillate was neutral and odorless. The residue in the retort was filtered from the excess of carbonate of baryta, and upon concentration a small amount of crystals were obtained, which, with a lens, appeared to be quadrangular prisms. Upon decomposing their solution by the addition of sulphuric acid and gently warming, the aromatic smell was again perceived.

The residue from the first distillation was sour, but the actual amount of acid present was so small that an attempt at analysis would have been useless. It is certain however that during the fermentation, no free acetic acid was formed, and attempts to find it in combination were also fruitless.

The coagulum formed contains a large amount of oil; it is entirely insoluble in dilute acetic acid, is dissolved by caustic alkalies with evolution of ammonia. It is insoluble in carbonated alkalies, and is decomposed by treatment at a very gentle heat (30° to 40° C.) with a moderately strong solution, with escapement of ammonia. As the alkaline solutions of this and of the precipitate by acetic acid are not thrown down by alcohol, it is not necessary that they should be absent from the fluid before proceeding to precipitate the emulsine. The fermentation takes place without any visible evolution of gas, unless allowed to remain till the liquid begins to putrefy.

The ashes from the syrupy liquid from which the alcohol had been distilled have a strong alkaline reaction, and contain a large proportion of potash.

The above facts lead to the conclusion, that the souring of an emulsion of sweet almonds has a very close resemblance to that of ordinary milk. The presence of lactic acid in a state of combination has been proved in the sour liquid, and there can be no doubt that the free fixed acid formed is also the same. The conversion of the sugar into lactic acid and the union of this acid with the bases which had held the caseous substance in solution, accounts for the appearance of the coagulum, and the subsequent non-appearance of a precipitate of acetic acid, as soon as sufficient acid has been generated by the fermentation, to precipitate all this caseous matter from its union with the alkalies.

I come now to the elementary composition of emulsine, the analysis of which was rendered very difficult by the large amount of inorganic matter with which it is encumbered, and which will account for the otherwise too great variation in the results. Notwithstanding this disadvantage they are sufficiently constant to

show that the substance precipitated by alcohol has a fixed composition. The analyses were made from emulsine of four different preparations, dried at 100° C., a process which required several days, from the tenacity with which it retained moisture. No. 6, was dried at 130° C. The analysis No. 5, was made from emulsine prepared in the following manner. The fresh almond emulsion thoroughly agitated with ether, to dissolve the oil which was present, was allowed to stand in a closely stopped vessel till the liquid had evaporated in two parts, which occurred in the course of a few days. The upper portion, a solution of the oil in ether, was a thick opaque somewhat gelatinous mass. The under watery liquid was filtered off and immediately precipitated with alcohol. Its composition will be seen not to vary materially from that of the others.

I. ·354 grm. substance containing 23·78 pr. ct. of ash, equal to ·2698 grm. ash free, gave with chromate of lead ·435 grm. carbonic acid and ·170 water.

II. ·565 grm. substance containing 35·79 pr. ct. of ash, equal to ·3607 grm. ash free, gave with chromate of lead ·5825 grm. carbonic acid and ·233 grm. water.

III. ·499 grm. substance containing 35·79 pr. ct. ash, equal to ·320 grm. organic matter, gave with chromate of lead ·5015 grm. carbonic acid and ·2125 grm. water.

IV. ·5475 grm. substance containing 35·79 pr. ct. ash, equal ·3515 grm. ash free, gave with chromate of lead ·5415 grm. carbonic acid and ·2335 grm. water.

V. ·4575 grm. substance containing 21·95 pr. ct. ash, equal to ·357 grm. ash free, gave with chromate of lead ·5735 grm. carbonic acid and ·2235 grm. water.

VI. ·6455 grm. substance containing 34·83 pr. ct. of ash and equal to ·4206 grm. ash free, gave ·6655 grm. carbonic acid and ·280 grm. water.

VII. ·356 grm. substance containing 23·78 pr. ct. ash, equal to ·269 grm. organic matter, gave with soda lime ·492 grm. chlorid of platinum and ammonium.

VIII. ·5203 grm. containing 21·95 pr. ct. ash, equal to ·406 grm., gave with soda lime and subsequent ignition of the precipitate of chlorid of platinum and ammonium ·3265 metallic platinum.

IX. 1·2197 grm. containing 25 pr. ct. ash, equal to ·9147 grm. after mixture with nitrate of baryta and subsequent oxydation by fuming nitric acid, according to Weidenbusch's method of estimating sulphur,* gave a precipitate of ·0935 grm., which after ignition, treatment with dilute hydrochloric acid, and a second weighing, amounted to ·086 grm. sulphate baryta, corresponding to ·0118 grm. sulphur.

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* Annalen der Chemie und Pharmacie, vol. lxi, page 371.

	1	2	3	4	5	6
C	43·59	43·74	42·75	42·09	43·08	43·15
H	6·96	7·33	7·37	7·34	6·81	7·39
N	11·64	11·40	11·52	11·52	11·52	11·52
O	1·25	37·53	38·36	39·05	38·59	37·94
S	36·56					
	100·00	100·00	100·00	100·00	100·00	100·00

The above analyses lead to the formula $C_{36}H_{35}N_4O_{24}$.

	Average found.	Calculated.
C_{36}	43·06	43·29
H_{35}	7·20	7·01
N_4	11·52	11·22
$O+S_{24}$	38·22	38·48
	100·00	100·00

Emulsine loses its capacity of reacting upon amygdaline with formation of bitter almond oil and hydrocyanic acid after exposure to a boiling temperature in solution, but retains this property very distinctly after exposure in a dry state to a heat of 100° C. for hours in succession.

Berlin, Prussia, Dec. 1848.

ART. VIII.—*Observations on Terraces;* by JAMES D. DANA.

(Continued from vol. vii, p. 14.)

THERE is one point in the history of terraces which was not dwelt upon perhaps with sufficient fullness in my former communication, and an additional paragraph is therefore here presented. But before entering upon it, I may make a few brief remarks on the observations by Mr. Chambers, in a preceding part of this volume.*

In my former article, no particular kind of terraces was described; those in view were such as Mr. Chambers mentions in his work, if I may judge from his descriptions, and his comparisons to the terraces of this country. The remarks offered were intended simply as a statement of the effects of an elevation in producing terraces of different kinds simultaneously,—a detailed enumeration of those tests, which might prove whether a deposit were marine or not,—and a notice of the mode of fixing the exact value of these different tests in the cases in view; and it was added that if no one of the tests of marine action could be detected in the course of one or two hundred miles along the length of a valley, we should hesitate before asserting that the deposits were marine. The evidence used for other strata is no

* Page 33.

less needed here, especially if we consider the wide theory based upon the facts. And I see not, by what authority, a private "protest" can be entered against such a course of investigation. Marine relics are too common a proof of elevations of coasts in all climates to be pronounced necessarily absent upon an uncertain general principle.

An examination of American terraces, has led me to believe that in general, the terraced plain corresponds in its seaward slope with the descent of the river, although apparently horizontal. The most skillful use of the best instruments is often necessary to test the horizontality: for the descent of most of our rivers, for a considerable part of their course is less than one foot in a mile. The Connecticut, from Springfield to the sea, falls sixty-four feet, which is one foot a mile (not reckoning the irregularities of its line); deducting for Enfield Falls, thirty feet, it leaves only ½ a foot a mile. The same river at Hanover, 175 miles in a direct line from its mouth, is 365 feet above the sea; and deducting 30 feet for Enfield Falls, 50 feet for Hadley Falls, 70 for Miller's and Montague's, 50 for Bellows, and 36 for White River, and also deducting 30 miles in length for the space occupied by these several falls, it leaves for the rest of the descent about $\frac{9}{10}$ of a foot a mile. The Mississippi from the mouth of the Ohio to the Gulf of Mexico, a distance of 1100 miles, has an average descent of only 3½ *inches to the mile*, and the Ohio in 950 miles, averages but 5 *inches*.

Again, if horizontality is proved, as apparently in Glen Roy, *the question of a lake origin* comes up for investigation.

Hence the apparent horizontality insisted upon, may still require further examination; and if absolutely demonstrated for all the various terraces described, the question of origin yet remains open for investigation.

The proof as regards Scotland is not so satisfactory but that some prominent geologists who have been on the ground—Macculloch, Buckland, Agassiz, Mr. David Milne, and others—have taken a view directly opposed to that of Mr. Chambers.

The continuity of line between a seashore and inland terrace, cannot prove the seashore origin of the whole. I have already shown that the same elevation must produce simultaneously marine and river terraces. If the country forming the valley of the Mississippi were raised, from the Gulf of Mexico north, there would in some places be a terrace along the sea;—there would also be rapid excavations by the descending river encroaching on its planes either side, and causing ultimately new bottom-lands many miles in width, with a terrace slope as their boundary; and the terrace slope of the river would be necessarily continuous with the "benches" of land bordering the sea and estuary. Will this continuity prove the whole to have

been a sea-beach? And at the mouth of the Ohio, will the height of the terrace plane *above the sea* be a measure of the elevation that took place? Terraces of the same epoch would extend up the Mississippi more or less interrupted, another 1000 miles and beyond; and *the height above the sea*, if the measure of the elevation, would prove an increase northward, while the actual fact might be a uniformity throughout, or even a somewhat less elevation to the north. The formation of wide bottom lands from such a cause cannot be doubted, for their actual existence about nearly all rivers proves it; other considerations may hereafter be brought forward by the writer to illustrate this subject.*

The point to which I would now direct attention is one of fundamental importance in these investigations. It is this:—The *deposition of the stratified material which is terraced, and the formation of the terrace plane and slope, are not necessarily of like origin.*

Whatever be the nature of the material that constitutes the Mississippi region, whether river detritus, accumulations by glacier action, or a filling in from the sea while the land was at a lower level, the river would flow on as now; and if an elevation were to take place, the material existing there would be terraced, whether of one or the other origin. As above explained, there might be terraces of river origin, although the material were from a marine or glacial source: and the evidence from the terraces with regard to amount of elevation would be the same in either case. Hence the question of the origin of the material and that of elevation are in part distinct. There may be river terraces, therefore, with the deposits either fresh or marine; but it still holds that those of sea-beach origin must admit of proof to this effect from some character, manifest in one place or another in the course of a distance of one or two hundred miles.

Here then is another point, complicating still farther the investigations respecting terraces. In the discussions upon drift,—which have referred in part to the very material that constitutes the upland terraces—geologists are divided among the following theories. 1. That of marine transport during submergence;—2. that of marine transport over the emerged land, in consequence of violent earthquake action;—3. that of lacustrine or river origin;—4. that of glacier origin;—5. (as we recently learn) that of sea-beach origin:—and the arguments for each hypothesis are strongly urged. It is hence obvious that there is the highest necessity, before deciding upon these subjects, that every possible aid in search of truth be employed.

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* See Report by the writer on Geol. Expl. Exped., pp. 659, 671.

It should hence be remembered that—

If the material is not marine in origin, in any part, it may be glacial, or lacustrine, or else a result of running fresh waters in one or another mode: and the terraces may be either river, lacustrine, or glacial terraces, and cannot be "sea margins."

If the material is of marine origin, it may be either of sea-beach or deep water formation, and the terraces may be either a result of action along sea margins, or estuaries, or rivers, or bordering lakes, or bounding glacial valleys. These are points for investigation which no protests can set aside.

ART. IX.—*On some principles to be considered in Chemical Classifications;* by T. S. HUNT, Chemist to the Geological Survey of Canada.

(Continued from vol. vii, ii ser., p. 405.)

IN illustration of this proposition, let us consider the basic relations of the different classes of coupled compounds—1st. Acids with alcohols; if in some cases it were difficult to determine which is the body losing the hydrogen replaceable by a metal, an examination of the ethers would readily remove the difficulty, for as already observed, those of the hydracids show that the acid is the species to which the ether is to be referred, and by analogy, all the ethers and vinic acids are to be regarded as species of the saline genus to which the forming acid belongs. In accordance with this deduction and with the law of basicity already cited, the ethers of monobasic acids are neutral, those of bibasic acids, with one equivalent of alcohol monobasic, and with two neutral, while a tribasic acid produces, with three atoms of an alcohol a neutral ether, and with one a bibasic vinic acid. In these the alcohol acts as a neutral body, and hence for phosphovinic acid $3+0-1=2$, but the alcohols are really in a feeble degree saline and monobasic, as is shown in such compounds as $C_2(H_5\,K)O$ and the mercaptids; if they were to preserve this character in combination, the ether of a monobasic acid would be itself monobasic. Cahours has found that the ethylic and methylic ethers of salicylic acid, which is monobasic, are capable of exchanging an equivalent of hydrogen for potassium or barium, so that the salts thus formed are in fact the ethers of potassic alcohol and methol. These ethers do not possess the power of combining with ammonia, and are thus distinguished from ordinary monobasic acids; we cannot substitute NH_4 for H in alcohol, which seems to be the reason of this apparently anomalous behavior of these ether-acids with ammonia.

Acids with Ammonia and other alkaloids.—The relations of the amids to the ethers have been before noticed, as showing a

close correspondence between the two classes of compounds; the law of their basicity is known to be the same as that of the ethers. The monobasic amid acids correspond to bibasic non-azotized ones, the bi-amids of which are neutral. The suggestion which M. Gerhardt with his usual profound sagacity advanced several years since, that all the azotized acids (the nitric ones excepted) were acid amids, is strongly supported by late researches.*

Ammonia like the alcohols, has the power of exchanging the whole or a part of its hydrogen for a metal, as in Kane's amidids of mercury, and such compounds as NK_3 and NHg_3, and we might therefore expect to find the amids occasionally exhibiting saline properties due to this; accordingly, Laurent has found that asparagine is capable of exchanging one equivalent of hydrogen for potassium, and Piria has described crystalline compounds with silver and copper of analogous constitution. Asparagine is the binamid of the bibasic malic acid, and should therefore in accordance with the general rule be neutral, while it is in truth monobasic; at the same time its acid characters are but feebly developed, when compared with proper acid-amids as the aspartic and oxamic acids, for the reason that they are only those belonging to ammonia. Certain anhydrid amids exhibit the same tendency to exchange their hydrogen for a metal, e. g., paramide, and prussic acid, which is the formic anhydrid amid. The anilids and naphthalamids, as far as examined, appear to be subject to the same laws as the amids.

Acids with Carbohydrogens.—The stronger mineral acids only, form combinations with these bodies; the sulphuric generally yields with one equivalent, a monobasic acid, in which an equivalent of its hydrogen is replaced by the elements of the hydrocarbon $-HO$, and a neutral body with two equivalents, e. g., benzene and naphthalene. These compounds, as M. Gerhardt has observed, are analogous to sulpho-methylic acid and sulphomethol.

Sulphomethylate,	$S(H(CH_3))O_4$
Sulphomethol,	$S(CH_3)_2\ O_4$
Sulphobenzite,	$S(H(C_6H_5-O))O_4$
Sulphobenzid,	$S(C_6H_5-O)_2O_4$

The products which nitric acid forms with an equivalent of these bodies throw much light upon the constitution of these and allied compounds; the first result of the action is generally the formation of a neutral compound analogous in composition to the sulpho-acids just mentioned. Benzene (C_6H_6) yields nitrobenzid ($C_6H_5NO_2$), which corresponds to nitric acid in which C_6H_5-O replaces H, thus $N(C_6H_5-O)O_3$. These analogues of the ethers sometimes regenerate the acid and organic substance

* See Piria on Asparagine, Am. Journal for Nov., 1848.

by the action of alkalies (as nitronaphthalene), but more frequently the decomposition is less simple. By the prolonged action of nitric acid aided by heat or the presence of concentrated sulphuric acid, the compound first formed reacts with another equivalent of the acid, eliminating a second time an equivalent of water; the nitric species indeed comports itself with the acid, in all respects like the normal one, and the product is still neutral. In like manner some monobasic acids, as the benzoic, yield with nitric acid, two or three acids, containing respectively one, two and three equivalents of the nitric elements. These are strictly monobasic, notwithstanding the apparent contravention of the law $S = \Sigma - 1$, and if we consider their constitution in accordance with the principle before laid down, we shall find that the second nitric body is to be regarded as a coupled compound of the first, and so on. Thus nitrobenzid being nitric acid where $C_6 H_5 - O$ replaces H or benzenic nitrate, binitrobenzid is nitrobenzenic nitrate, where $C_6 H_5 NO_4 - HO = C_6 H_4 NO$ replaces the hydrogen of a second equivalent of nitric acid; this being derived from a monobasic acid and a neutral body, is necessarily neutral. The same principle is applicable to the nitrobenzoic acids, as it is each time a monobasic acid which is coupled with the nitric acid; nitrophenisic acid contains the elements of three equivalents of nitric acid, and yet possesses but one equivalent of replaceable hydrogen, because the saline hydrogen of all these has been eliminated, and only the original saline atom of the phenol remains. Representing this acid as phenol, in which NHO_2 replaces H_2, thus; $C_6(NHO_2)O$,* it is difficult to see why it should not be tribasic.

The coupled acids which the sulphuric forms with many organic acids, are striking illustrations of Gerhardt's law; with one equivalent of a monobasic acid, the compound is bibasic, but with a bibasic acid as the succinic, it is tribasic; the elements of the succinic acid retaining in combination their saline capacity, while the sulphuric has lost one equivalent of its hydrogen. The ethers and ether-acids of these coupled bodies as the sulphacevinates of Melsens, show how far these principles may be extended in the study of organic compounds.

It now remains to consider the nature of that class of chlorinized compounds in which chlorine may be regarded as replacing hydrogen, equivalent for equivalent. The close analogies subsisting between the ethers of oxygen acids and the sulphuric and nitric copulates of the hydrocarbons being kept in view, we see in $C_2 H_5 Cl$, (acetene chlorè, Gerhardt,) the ether of hydrochloric acid, which is at the same time a chlorinized species of acetene, $C_2 H_6$.

The relation between phenol and benzene, is precisely similar to that which exists between alcohol and acetene, and the hydro-

* Precis, tom. 1ier., p. 97.

carbons are allied to certain oxygenized compounds, as H_2 is to H_2O. Alcohol with HCl eliminates H_2O, and produces C_2H_5Cl, but if it were to eliminate chlorinized water (ClH)O, it would afford normal acetene (C_2H_6). Phenol under certain circumstances may probably react with HCl, and yield chlorinized benzene, C_6H_5Cl.* The monochlorinized compounds correspond to copulates of hydrochloric acid, and the products of the farther action of chlorine with the elimination of HCl, are species related to the parent acid, as binitrobenzene is to nitric acid; chlorinized acetene is HCl, in which $C_2H_4-H=C_2H_5$ replaces H, and bichlorinized acetene is equally HCl where $C_2H_3Cl-H=C_2H_4Cl$ is substituted for the same atom.

The principles which we have attempted to develop in the preceding pages are dependent upon a more fundamental one which I have briefly announced in a late paper, and which assumes that the various saline forms are reducible to two, the types of which are seen in water H_2O, and the protoxyds M_2O, and in hydrogen H_2 or the metals M_2; the first includes all oxygenized acids and the second the hydracids. But as many neutral oxygenized compounds which do not possess the saline character are still derivations of acids which are referable to the type of H_2O, we may regard all oxygenized substances as belonging to this type. As nitric acid and alcohol are water, an equivalent of whose hydrogen has been replaced by non-saline elements, (NO_2 in the one case and C_2H_5 in the other,) and are necessarily monobasic, so is hydric ether, the result of the complete replacement of the hydrogen, a neutral substance.†

In the same way M_2 is the type of the hydracids in which one atom has been replaced by chlorine; of the metallic chlorids; of the molecule of chlorine ClCl; of the metals and their various alloys; and moreover it follows from the relations of HCl to the chlorinized hydrocarbons, of all that numerous class of combinations which are composed of those two elements, as well as the alkaloids which may be regarded as amidized species of them and which are equally susceptible of substitutions by chlorine.

In considering the relations of the various ethers and the chlorinized species of the oxygen acids, the two formed seem so closely assimilated that it is difficult to discriminate between them,

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* This may probably be effected by distilling a sulphophenate with an alkaline chlorid; by substituting a nitrate or other salt, we should expect to obtain a series of compounds corresponding to ethers.

† Am. Jour., Sept., 1848, p. 173, and Memoirs of M. Laurent, An. de Chem. et de Phys., Nov., 1846. While nitric acid NHO_3 is $H(NO_2)O$, the result of the complete replacement of H will be $(NO_2)_2O$ or the unknown dry nitric acid, homologue of the so-called anhydrous phosphoric and arsenic acids, which are equally $(PO_2)_2O$, &c. The formation of the arsenic anhydrid by heat is evidently the reaction between 2 eq. of the acid eliminating an equivalent of water, $AsHO_3=(H(AsO_2)O+(H(AsO_2)O=(AsO_2)_2O+H_2O$.

and a farther inquiry shows that they are indeed the same, or rather that one is a simple derivative of the other. The relation is that which exists between alcohol and acetene, or water and hydrochloric acid. If a molecule of chlorine (Cl Cl) reacts with one of a metallic oxyd $M_2 O$, it generates a chlorid in which one of the atoms of Cl is replaced by M, and a hypochlorite which is (Cl M)O. The origin of the form $M_2 O$ is then the replacement of M in M_2 by the elements of an oxygenized body $-M$; the reaction therefore eliminates two new bodies of the same forms as the originals.

It will be seen that I have in this exposition recognized the theory of double atoms first advanced by M. Ampère and since so ably supported by M. Laurent.* The idea which he at first applied to the reaction of chlorine and hydrogen, to explain the formation of hydrochloric acid in accordance with the received theory of double decomposition, is in fact the principle which governs all that class of reactions which have been considered in the present essay and which find their type in the mutual decomposition by which HH′ and Cl Cl′ become H Cl H Cl′.

The chlorids of bromine and iodine as $I Cl_5$, I have in the paper previously quoted, referred to a polymeric modification of this type which may be represented by M_6, to which belong also $P Cl_5$ and $As Cl_5$, while $P Cl_3$ and the corresponding compounds, are species of another polymere which is composed of two molecules or M_4. The existence of polymeric organic compounds being established, it might be expected that similar affinities would be operative among less complicated bodies and even among the elements themselves; but I believe the first application of the idea was in the paper already referred to, where an explanation of the anomaly in the density and combining volume of sulphur vapor was proposed, upon the ground that crystalline sulphur was a combination of these molecules of sulphur in one, whose equivalent as deduced from its vapor and the comparison of its atomic volume with that of oxygen was shown to be 48, (O=8), and its formula consequently S_3. The *allotropic* form of oxygen known as *ozone* was suggested to be a polymeric modification of the element corresponding to S_3 and SO_2, to both of which it seems allied by its properties.

I think that the application of a similar view will explain many if not all of the so-called cases of *allotropism*, which do not appear to differ from the phenomena characterized in organic chemistry by the terms *isomerism* and *polymerism*. Two states of the metal chromium have been distinguished; the one soluble in hydrochloric acid and the other resisting the action of aqua-regia.

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* See his Memoir Recherches sur les combinaisons azotés, already quoted, Ann. de Chem. et de Phys., Nov., 1846.

The first corresponds to iron and the allied metals in their ordinary condition, while the second appears to be connected with M_2 which in permanganic and perchromic acids, is found equivalent to Cl. The *passive* state of iron induced by electricity and many other agencies, suggests itself as analogous to that of insoluble chromium.*

The constitution of gaseous nitrogen as I have shown in the previously quoted paper is probably NN, (N = 7 – O = 8,) corresponding to the two volumes of vapor, and differs in the condensation of its molecule from its congeners, phosphoric and arsenic in their ordinary condition. May not the allotropic condition of phosphorus alluded to by Berzelius, be an analogous molecular condition of this substance? The question would be solved by a determination of its density in that state.

The difference in the specific densities of the two crystalline forms of carbon, seems to indicate that the diamond has double the atomic weight of graphite, and there are reasons for supposing that charcoal is a still higher polymeric modification of the elementary carbon.† If these suggestions lead to an explanation

* Those substances which are considered elementary may change their equivalents at the same time undergoing a corresponding change in their density, and as we obtain from the ordinary equivalent and density an idea of "*the volume of the atom*," we say of those forms having an increased density and a corresponding increase of equivalent (so that the atomic volume remains unchanged), that two or more of the ordinary molecules have united in one. This is illustrated in the case of sulphur, and also in those salts of mercury and copper where these metals unite in twice their ordinary equivalents. In the one *mercurecum* (Gerhardt) with an atomic weight of 100, (H=1) is the equivalent of H; in the other, *mercurosum* (G.) =200, enjoys the same power in combination. So of Cu *cupricum*, and Cu_2 *cuprosum*, atomic volume with it,‡ are cases in point, and we might say that the atom of iron has one-third the commonly received equivalent, and that Feβ is made up of two and Fe of three atoms of elementary iron. The so-called elements may then possess different atomic weights which enjoy a simple relation to each other, and in these different states exhibit very different characters. When we speak of one of these as containing two or three atoms of another form, condensed in one, it is only an expression, in accordance with previously existing ideas. We can no longer attach to the atomic weights of the supposed elements, an absolute value, and thus one of the characters which served to distinguish them from known compounds is rendered of no importance.

† The experiments of Mr. Hatchett, (Philos. Trans., 1805,) show that charcoal, by the prolonged action of nitric acid, is dissolved and converted into a soluble, astringent, azotized body, described by him as *artificial tannine*, which has all the characters of an organic substance of a pretty high equivalent. As the action of oxydizing agents seldom if ever results in the production of a body higher in the organic scale than the parent substance, and as we can scarcely expect the polymorphosis of elementary carbon under the circumstances to form an organic body, I am led to suspect that charcoal is a species of anhydrid derived from cellulose, possessed of a high equivalent, and capable under the action of an acid of taking up the elements of water to form a substance which by the fixation of nitric acid and oxydation, produces the substance in question.

The researches of Johnson upon paracyanogen, which is in fact a sort of azotized charcoal, are worthy of consideration in this connection. The body derived from charcoal has not, so far as I am aware, received any attention since the experiments of Mr. Hatchett; I have commenced an examination of it, and hope before long to determine something with regard to its real nature.

‡ This Journal for Nov., 1847, p. 405.

of the hitherto mysterious phenomena which have been designated as arising from *allotropic conditions* of the elements, they may not be deemed unworthy of notice.

Having grouped together under the saline type of M_2, with the oxygen type and their polymeres, by far the greater number of all the forms of matter with which our science is cognizant, we find still unclassified azote, phosphorus, arsenic and antimony, with carbon, boron and silicon. The first four constitute a well defined natural group, and the remaining are generally arranged together from the similarity in their physical characters as well as in their saline derivatives; this is remarkable in the borates and silicates. Silicon is related to the metals through columbium and titanium; these analogies are however found connecting in various ways the other groups, and there appear to be good reasons for making carbon, boron and silicon a fourth class, to which the submetallic bodies above mentioned, may perhaps be added.

This fourfold division of inorganic matter being established, it becomes desirable to find some significant terms which may serve to designate the several groups, and I would suggest the following as perhaps as little objectionable as any. The first four, of which water may be taken as the representative, is the *Hydristic;* the second, of which oxygen is the type, is the *Oxystic;* the third, after its most abundant species, is named the *Nitristic*, and the fourth, for a similar reason is called the *Silicistic* form.

Having in the previous pages advanced some of the principles which, as I conceive, are to guide us in chemical classification, and followed them out to their results, I leave the subject to the consideration of philosophers. Believing in their truth and their universal application, I shall be more than rewarded if the views here developed shall resolve in a single mind, some of the difficulties which environ the science, and shall tend in any way to direct attention to the great field for research which lies before the philosophic enquirer.

I have exposed without hesitation, what I conceive to be the fallacies of the schools of the day; but my object has been to show their merits rather than their defects, and to exhibit their real harmony with each other and with nature. The views which I have advanced, are in fact deduced in great part from the labors and investigations of Liebig, Gerhardt and Laurent, whose illustrious names will be enrolled in the history of the science of their age, as the Coryphæi of chemical philosophers.

ART. X.—*Thoughts on Ancient Metallurgy and Mining in Brigantia and other parts of Britain, suggested by a page of Pliny's Natural History;* by JOHN PHILLIPS, Esq., F.R.S., F.G.S.*

To one who meditates on the progress of natural knowledge, the difficulty of penetrating to a true estimate of its condition in past ages often appears unconquerable, except in cases which admit of the interpretation of ancient results by modern laws and theories. Once in firm possession of such laws, we enclose the old phenomena, so to speak, in a field to which are only such and such possible avenues, and thus can sometimes declare the very mode by which the alchemist was led to his golden error, and the Chaldæan shepherds to brighter truths. Without this principle of interpretation, many almost modern writers, nay authors of this very century, can sometimes not be understood. The laws of modern geology and zoology, for such there are, and well-founded too, are as much required to put a true construction on some of the writings of Lister and Linnæus, as the methods of Ray, Linnæus, and Cuvier are required for the just estimation of Aristotle. We shall probably find the darkest pages of antiquity to be precisely those which refer to subjects where our own knowledge is least clear, least collected into laws of phenomena, and most removed from laws of causation. Ought we not, before declaiming on the ignorance of the ancients, to be careful to make allowance for the differences of form in which knowledge presents itself at different periods, as well as for the incompleteness of *their* records, and the imperfection of *our* interpretations?

Pliny's Natural History appears to me to be precisely in the very position of difficulty which has been alluded to. Its vastness, variety, and seeming disorder, may well deter the most comprehensive master of modern science from duly weighing its mass, or even measuring its surface; and the evident incompleteness and almost hap-hazard character of its chapters are apt to disgust the student of special branches of science and art. Yet, probably, if for each important branch of human knowledge handled by Pliny, a special editor were set to work, well versed in the philosophy of his subject, Pliny would take a higher degree on examination, and the history of human knowledge be amended.

From the thirty-seven books of diffuse and erudite learning, the genuine work of Pliny the elder, let us fix on the part which treats of the nature of metals; and passing over his lamentations on the useless excess of gold and silver—which may be recom-

* From the Proceedings of the Yorkshire Philosophical Society for March, 1848; and here cited from the London, Edinburgh and Dublin Phil. Mag., April, 1849.

mended to the Chancellor of the Exchequer—his accounts of the uses and properties of gold, electrum,* chrysocolla, silver, quicksilver, stibium, scoria argenti, spuma argenti, minium, cinnabar, brass, cadmium, iron, and many compounds of metals, let us pause at the 16th chapter of the 34th book, which treats of the metals of lead, white and black.

"The most precious of these, the white, is called by the Greeks καττίτερος, and fabulously declared to be sought for in isles of the Atlantic, to which it is brought in wicker vessels, covered with leather, (vitilibus navigiis corio circumsutis.) But now it is ascertained to be indigenous in Lusitania and Gallicia, in sandy surface soil, of a black color, and only distinguished by its weight. Small pebbles [of the ore] also occur principally in dried beds of streams. The miners [metallici] wash these sands, and what subsides they melt in furnaces.

"It is also found with the gold ores (aurariis metallis) which are called stream works (elutia), the stream of water washing out (eluente) black pebbles a little varied with white, and of the same weight as the gold. On this account, in the vessels in which the gold is collected, these pebbles remain with it; afterwards they are separated in the chimneys† (caminis separantur), and being melted are resolved into plumbum album.

"In Gallicia plumbum nigrum is not made, because the adjoining Cantabria [Asturias] so much abounds in that metal.

"Not out of white plumbum as out of the black can silver be extracted.

"To solder together [pieces of] plumbum nigrum is impracticable without [the use of] white plumbum, nor the white to the black without the addition of oil. Nor can [pieces of] white plumbum be soldered together without the aid of the black metal.

"That [plumbum] album was in esteem during the Trojan time Homer is witness, who calls it καττίτερος.

"Of plumbum nigrum the source is double: either it comes from its own vein, without admixture, or grows with silver, and is melted while mixed with that metal. The part which is first liquid is called stannum,‡ that which flows next is silver, that which remains in the furnace galena,§ which is the third portion of the vein (or ore). This being again melted‖ yields plumbum nigrum, [the other] two parts [of the ore] being deducted."

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* Gold with one-fifth of silver.

† What distinctive meaning should be attached to furnaces and camini is uncertain. It seems that the camini may indicate, if not what we call chimneys, at least cavities in or above the furnace.

‡ Analogous to this is the process of separating silvery lead from mere lead, invented by H. L. Pattison, Esq.

§ Lib. xxxiv, cap. 18. Est et molybdæna, quam alibi galenam vocavimus, plumbi et argenti vena communis.

‖ At the present day we should perform this melting of the residual 'galena' in the slag-hearth, with a flux.

This chapter is a text on which a 38th book of Natural History might be written, embracing the history or fable of the κασσιτέριδες, the ancient arts of metallurgy, and the eager trade in metals which allured the Phœnician sailors on the Atlantic, and led the Roman armies to Britain.

What is κασσίτερος, for which plumbum album is the equivalent? what is stannum, obtained from mixed ores of silver and lead? what is galena, elsewhere called molybdæna? (cap. 18.) We need not ask what is plumbum nigrum, for by that is clearly designated lead.

That κασσίτερος or κασσίτερος was tin, appears to be generally allowed. The mineralogist and miner who know the mode of occurrence and character of tin ore, will have no doubt that plumbum album of Pliny is tin, and that author twice positively and expressly identifies this with κασσίτερος.

The uses to which Homer puts κασσίτερος in the thoraca and shields of Agamemnon, Achilles, and Asteropæus, and in the greaves of Achilles, are such as imply easy fusibility and ductility, and indicate that the metal was highly valued and almost precious.*

Virgil puts no tin into the arms of Æneas—perhaps the metal was then of too vulgar use—employed too much by tinkers—to be fit for a heroic shield. Electrum is substituted, and iron is the staple article in the Vulcanian workshop, as brass was in that of ΗΦΑΙΣΤΟΣ, 1000 years before.

The picture of the great artist—the Tubal Cain of the west, the cunning worker in metal, who melted, alloyed, inlaid, carved, and polished his work—whose multiplied bellows breathed at the will of the god softly or fiercely—whose brass was hardened to wound, or tempered to bend,—is perfect, and might be paralleled on a small scale till a few hundred years in the famous smiths of

* The following are the principal passages in the Iliad where κασσίτερος is mentioned:—

XI. 25. In the thorax of Agamemnon were ten plates (σῖμοι) μέλανος κυάνοιο, twelve of gold and twenty of κασσίτερος.

XI. 34. In the shield of Agamemnon were twenty white bosses (ὄμφαλοι) of tin, and in the middle one of κύανος.

XVIII. 474. For the shield of Achilles ΗΦΑΙΣΤΟΣ throws into his crucibles brass, unconquered κασσίτερος, honored gold, and silver.

XVIII. 564. He pours the tin round the border.

XX. 270. In this shield were five plates; the two exterior ones brass; within these, two of κασσίτερος; and in the middle of all, one of gold.

XVIII. 612. The greaves of Achilles are made of soft κασσίτερος.

XXII. 503. The chariot of Diomedes was adorned with gold, and κασσίτερος.

XXIII. 561. In the brazen thorax of Asteropæus the ornament was of glittering κασσίτερος.

What is here called κύανος, and is apparently a much-valued substance, is difficult to say. From its color, lapis lazuli, turquois, and carbonate of copper have been suggested. As it is only mentioned in connexion with the arms of Agamemnon, which was the gift of Cinyras king of Cyprus, the latter mineral may be thought to have the best title, especially if, as at Chessy, it occurs blue in Cyprus.

Wales, who made their own iron, and were by the laws of that country, as renewed by Howell Dda, allowed to sit next the sacred priest.

Why Pliny treats as a fable the story of the Cassiterides yielding tin, is somewhat difficult to say. He classes the Cassiterides with Hispania, book iv. cap. xxii. (ex adverso sunt insulæ,—Cassiterides dictæ Græcis, a fertilitate plumbi,) and speaks of Mictis (on the authority of Timæus the historian) as six days' sail from Britain, and as yielding candidum plumbum, iv. cap. 16. If the Cassiterides are the Ocrynian Promontory and the Scilly Isles, from which, as recorded by Strabo, the Phœnicians drew their tin, (Ἰκτις of Diodorus, Μίκτις of Timæus, and Οὔηκτις of Ptolemy being Vectis or Wight, from which the tin was carried through France to Marseilles,) we may suppose that in the early period the only route for the tin of Cornwall to the Mediterranean was by sea to the western parts of Spain; but that in the latter period the track by land through Gaul to Massilia was preferred, and the old trade had become a tradition which Pliny chose not to adopt from Strabo, who is never quoted on this subject by the author of the *Historia Naturalis*, but may be obliquely and slightingly alluded to. Whether tin occurs at all in any part of the Spanish Peninsula can hardly be doubtful after the assertion of Pliny. He had been procurator in Spain, and by his intimacy with Vespasian* must be supposed in position to learn much of Britain, from the despatches of Petilius Cerealis, Ostorius Scapula, and Agricola. But he was suffocated by the fumes of Vesuvius in '79, one year after the appointment of Agricola to Britain—and for the greater part of his literary life, Britain was a scene of never-ending war and confusion. Besides this, the Cornish promontory appears to have been at no time much occupied by Roman stations, or traversed by roads; and it may be thought to have had then, as afterwards in Saxon and Norman times, a history and commerce quite distinct from and little known to the Belgic settlers in Albion. He might be mistaken respecting Britain, of which perhaps he could know only Albion; but his positive assurance of the occurrence of tin in Spain is confirmed by a passage in Bowles's Natural History of Spain, and, as I hear from Mr. Kenrick, by a later German writer (Hopfensach); it occurs, in fact, according to one of our best books of mineralogy,† in beds in the mica schist of Gallicia. Oxyd of tin has been found, besides, on both sides of the Erzegebirge in granite, at Puy de Vignes (Haute Vienne), also in granite in Wicklow, on the east coast of Sumatra, Siam and Pegu, and in Banca and Malacca. It has been found in Mexico, Chili and Greenland, and mixed with other matters in Finland and Sweden.

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* Accessit imp. A. D. 69.

† W. Phillips, 1823.

Upon the whole, the case is probably thus. It is the old Phœnician trade, destroyed with Carthage, which Strabo describes, and Pub. Crassus went to explore in the κασσιτέριδες. Diodorus Siculus narrates the course of trade in the days of Augustus from Ictis, when Gaul offered an easy route to the Mediterranean; but 100 years of war and commotion interrupted this trade of Cornwall with the East, and Pliny was suspicious of the fables of Greece, and knew that tin was obtained in Spain. Notwithstanding this fact, it appears that Cornwall and the Asiatic Isles have been the principal, almost the only sources of the tin of the ancient world, that of Zinnwald being quite unknown till a much later date.

Stannum is evidently an alloy of an argentine or tin-like aspect—a variable pewter—a metal more easily melted than copper, for the lining of which it was much used in Pliny's days to obviate the danger of cupreous solutions. This process we now call tinning; and stannum,* with its variable meanings, is perhaps the common parent of the French *étain*, meaning as often pewter as tin; and of the German *zinn* which like tin in the English workshops, is used sometimes for pewter when lining vessels, and solder when covering surfaces which are to be joined. Our German silver, Britannia metal, &c., belong to this class. The process of illination with stannum must have been well executed to justify the exclamation of Pliny, that it did not augment the weight of the vessel to which it was applied. The Brundisian specula made of it yielded to silver, indeed, at last; but they are declared to have been of admirable efficiency.

Stannum, then, is an alloy of tin with lead, tin with brass, tin with antimony, lead with silver, or other variable mixtures of metals often associated in nature.

Pliny mentions adulterate or alloyed kinds of stannum, composed of one part *white brass* to three parts of candidum plumbum; of equal weights of candidum and nigrum (which is called argentarium); of two parts of nigrum and one of candidum (called tertiarum); with this last lead pipes are soldered.† Fraudulent dealers add to the tertiarium equal parts of album, call it *argentarium*, and with it plate or line other metals.

He gives the prices of these compounds and those of pure album and nigrum; the former twenty, the latter seven denarii for 100 lbs.

Plumbum album, he says, is rather of an arid nature; the nigrum is entirely humid; "therefore the white is of no use unless

* Pliny's notices of stannum are frequent. See Hardouin, vol. ii, 429, 22; 528, 7; 530, 30, 31, &c.

Stanno et ære mixtis, 627, 11—illitum æneis vasis saporem gratiorem facit, 669, 14—discerni vix possit ab argento, 669, 26—æramentis jungitur, 669, 11.

† Hoc fistulæ solidantur. This is the solder of our tinmen.

it be mixed with another metal. Silver cannot be leaded (lined) with it, it will be melted first."...." It is affirmed that if there be too little nigrum mixed with the album, the silver will be corroded by it. Album is melted into brass-work (inlaid, an invention of Gaul,) so that it can hardly be known from silver—these works are called Incoctilia" (silvered.) He then speaks of the application of this invention to the trappings of horses and carriages, and other curious productions of Alesia and the Bituriges, a subject which our esteemed Kenrick has lately handled with his usual felicity. One of Pliny's sentences is remarkable as narrating a class experiment fit for a chemical school: "Plumbi albi experimentum in charta est, ut liquefactum pondere videatur, non calore, rupisse."

The meaning seems to be, that the metal is fluid at so moderate a heat as when fused to break by its weight, not burn by its heat, the charta on which it is poured. Tin melts at 440° to 442°; lead at 612°.

What follows is a very important passage: "India neque æs neque plumbum habet, gemmisque suis ac margaritis hoc permutat."

May we be justified by this sentence in refusing to credit the supposition that tin (plumbum album) was brought overland or by other routes from the Asiatic Isles and shores towards Western Europe? If so, Cornwall chiefly, if not wholly, supplied the tin which entered so many ways into the comforts and necessities during peace and war of all the nations surrounding the Mediterranean and Euxine, Baltic and German Ocean; in fact, the world, as distinctly known to the Roman geographers.

Let us now inquire into the means whereby the ancient people reduced the metals which they were so earnest in seeking across mountains and oceans at the point of the sword. To confine the inquiry within reasonable limits, we shall speak chiefly of tin and lead, the only metallic products, as it appears, which were regarded by the ancients as abundant in Britain. [Iron is mentioned by Cæsar as of limited occurrence.]

Gold, the most widely if not most abundantly distributed metal —found near the surface of the earth, in a pure and malleable state, easily fused, uninjured by fusion—was probably the metallic substance on which the earliest processes of fire were tried, and they could not be tried unsuccessfully.

Tin, the ore of which has been found at the surface in many situations with auriferous sand and gravel, cannot have been long unknown to the gold-finders of the East and the West. Some one of the many accidents which may or rather must have accompanied the melting of gold, would disclose the nature of the accompanying white metal, whose brilliance, ductility, and very easy fusibility, would soon give it value.

The melting of *tin ore* is, however, a step in advance of the fusion of *native gold*. The gold was fused in a crucible (xxxiii, p. 617, Hard.) made of white clay,* which could stand only the heat and the chemical actions which that generated: but tin ore would in this way of operation prove totally infusible. It must be exposed at once to heat and a free carbonaceous element. The easiest way of managing this is to try it on the open hearth. Perhaps some accidental fire in the half-buried bivouacs of the Damnonii may have yielded the precious secret. As to the fuel, we are told that pine-woods were best for brass and iron, (Hard. xxxiii, p. 621;) but the Egyptian papyrus was also used, and straw was the approved fuel for gold. In the metalliferous country of Cornwall and Devon, peat is plentiful; and an order of King John (1201) allows the miners to dig tin, and turves to melt the tin, any where in the moors, and in the fees of bishops, abbots and earls, as they had been used and accustomed. (Confirmed by Edward I, Richard II. and Henry IV.)†

These and other singular privileges, extending as far as the land on which the crown claimed rights, are long anterior to the other rights of property in Cornwall, Mendip, Derbyshire and the Forest of Dean, and go far to justify the supposition of our modern mining laws, being a relic of Roman, or perhaps of earlier than Roman times.

As the bellows was known at least 1000 years before Pliny, we have here all the materials for a successful tin smelter's hearth. If the smelting work was on waste land, and a little sunk in the ground, we recognize the old 'bole' or 'bloomery' of Derbyshire, now only a traditional furnace, but anciently the only one for the lead and iron of that country.

Pure tin once obtained, there must intervene a long series of trials and errors before its effect in combination with lead, brass, silver, &c., could be known; before the mode of conquering the tendency to rust in the act of *soldering* could be discovered; oil being in this respect as valuable to the tinner as artificial chrysocolla was to the jeweller and goldsmith, (xxxiii, p. 621, Hard.) From all this, it follows that the smelting of tin might be, and probably was, performed by the inhabitants of the Cornish peninsula. This art they may have brought from the far east; Phœnicians may have taught it them; but all the accounts of the ancient tin trade represent the metal, and not the ore, as being carried away from the Cassiterides. Diodorus mentions the weight and cubical form of the tin in blocks, carried from Ictis to Marseilles and Narbonne; and Pliny says of the Gallician tin, that it was melted on the spot.

(*To be continued.*)

* Such as now is called Cornish clay, for example.

† De La Beche, in Report on Geology of Cornwall.

ART. XI.—*Chemical Examination of Algerite, a new mineral species;* by T. S. HUNT, *of the Geological Commission of Canada:* including a description of the Mineral, by F. ALGER, Esq. (Read before the Boston Society of Natural History by JOHN BACON, Jr., M.D.)

THE mineral here described was placed in my hands by Mr. Alger, more than a year since, with the following description.

"It is found in the town of Franklin, Sussex county, New Jersey. The crystals are imbedded in a white crystalline limestone, and are without any accompanying minerals excepting a few disseminated scales of graphite. They are occasionally two inches in length and rarely three, and are never more than one-eighth of an inch in thickness. Like sillimanite and scapolite they are frequently curved. They occur as single individuals and never in groups or radiating masses. When taken from near the surface, the color is a deep brownish-yellow, which is evidently due to their partial decomposition. Those found at the depth of twelve inches or more, are yellowish-white or straw-yellow, sometimes with a greenish shade; in a few instances I have found them perfectly colorless and possessing a good degree of translucency. Even the dark yellow crystals, when not decomposing, are slightly translucent, and they then bear a striking resemblance to chondrodite, with which the mineral, when first obtained in a few fragments, was supposed to be identical. It has also been referred to scapolite and spodumene, but it differs from both of these in form and hardness, as well as in other essential characters. In fact its hardness is even inferior to that of laumonite in fresh crystals."

"I believe that Prof. Nuttall was the first mineralogist who expressed the opinion that this mineral might prove to be a new species, but I am not aware that he ever entered into any investigation of its character to satisfy himself upon this point, and for the last ten years, it appears to have been entirely overlooked, the locality even not having come under the cognizance of any mineralogist since his visit to it, until recently explored by myself. The crystals are rhombic prisms; the faces M and M′ inclining to each other at an angle of about 94°, as determined by the common goniometer. In no case have I found an individual, having distinct terminal or basal planes by which to determine the angle of P on M, but an oblique termination of the prism is clearly indicated both by its natural joints and cleavage, so that we have an oblique rhombic prism as the primary form; the accurate measurements of which, farther examination must determine. None of the faces are sufficiently brilliant for the reflecting goniometer, although the imperfect cleavage surfaces which

may be obtained, parallel with the lateral planes of the prism, sometimes possess considerable lustre; they present a pearly reflection in spots, the prevailing lustre being vitreous. In its general aspect, when taken from near the surface, the mineral would be described as without lustre and transparency.

"The only modifications of the primary, which have been observed, are the replacement of the oblique and lateral edges of the prism by single planes; they exhibit no striæ."

The crystals are very sparsely disseminated through the coarsely crystalline limestone, and it was with difficulty, that I could obtain sufficient for the purposes of analysis. Those exposed to the weather had become quite friable from partial decomposition, and the larger crystals were more or less interpenetrated by the matrix which is a pure calcareous spar.

The specific gravity of four light-colored translucent crystals which had been selected with great care and weighed ·2685 grammes, was found to be 2·697, while 1·8 grammes of fragments gave the number 2·712; and some coarser crystals were found to have a specific gravity of 2·948. The hardness when unaffected by exposure is 3–3·5 (Alger); it is brittle, easily separated into fragments. Before the blowpipe it intumesces considerably, and at a high temperature fuses with phosphorescence into a white porous enamel. Pulverized and heated in a tube it gives off abundance of water; the powder moistened with a solution of nitrate of cobalt and heated on platinum foil, fuses into an ultramarine-blue frit.

The crystals selected for analysis were hard, semi-translucent and undecomposed; their powder even when elutriated and carefully dried was of a buff color which was not changed by ignition. The action of hydrochloric acid upon it at first evolves a little carbonic acid gas from the intermixed calc spar; by digestion it takes up a portion of potash, alumina, iron and magnesia, while a white granular residue remains. It is however impossible in this way to effect a complete analysis of the mineral, for even after long digestion the decomposition is found to be very incomplete. It was accordingly necessary to have recourse to fusion with an alkaline carbonate; the qualitative analysis thus effected, showed the presence of silica, and alumina with small quantities of iron, magnesia and lime; the iron probably exists as peroxyd from the color of the mineral, while the lime is evidently present as a carbonate from the fact that it is at once taken up by hydrochloric acid with effervescence. Another portion of the mineral decomposed by hydrochloric acid, in Laurent's apparatus, gave a large portion of potash, mixed with a little soda; no lithia could be detected in the alkalies.

The quantitative analysis effected by the process above mentioned, gave the following results.

Silica,		49·82	contains oxygen 26·60
Alumina,		24·91	
Peroxyd of iron,		1·85	
Magnesia,		1·15	
Potash, Soda-traces,		10·21	contains oxygen 21·11
Water,		7·57	
Lime,	2·20	3·94	
Carbonic acid,	1·74		
		99·45	

The composition of the mineral, deducting the carbonate of lime, is evidently a hydrated silicate of alumina and potash, in which small quantities of magnesia and iron, replace in part the alumina and water. Representing $Al^{\frac{2}{3}}$ (aluminicum) as $Al\beta$, and $Fe^{\frac{2}{3}}$ (ferricum) as $Fe\beta$,* we have, taking silica as SiO_3 and considering the Mg as replacing in part H and $Fe\beta$, the following formula as very closely expressing its constitution, $5SiO_3+4HO$, $KO, 6\frac{6}{7}Al\beta O$, $\frac{1}{7}Fe\beta O$ or $5SiO_3+12MO$, which if we take silica as SiO is evidently at once brought to $Si_5M_{12}O_{20}$, or in M. Gerhardt's notation $Si_5M_8O_9$, which is one of the typical forms which M. Laurent has deduced from his researches on the natural silicates. This requires a ratio between the oxygen of the silica and that of the other oxyds of 5 : 4, and that of the silica being 26·60, theory demands for the bases 21·28 while experiment gives 21·11. Although it will be difficult to arrange the elements found, in a satisfactory manner, according to the ideas of the dualistic school, this close correspondence establishes beyond a doubt the type of the compound.

I have deducted the carbonate of lime and determined the composition of the mineral for 100 parts, and then in accordance with the above formula calculated its composition according to theory. The two results are subjoined.

	Found.		Calculated.	
Silica,	52·28		52·08	
Alumina,	26·08		26·11	
Potash,	10·69		10·88	
Peroxyd of iron,	1·93	11·05	2·45	10·78
Magnesia,	1·20			
Water,	7·92		8·33	
	100·10		99·85	

The attempts to represent the composition of the natural silicates in accordance with the dualistic system, have tended perhaps more than anything else, to show its inadequacy to the

* Am. Jour. of Science, vol. iv, p. 407.

wants of the science. The unnatural complications of atoms which present themselves to the chemist in the usual mineralogical formulas, suggest that we are yet far from the simplicity of nature. In accordance with the unitary system on the contrary, M. Laurent has shown, that by considering the ratio between the oxygen of the silica and that which is contained in the bases present, and keeping in view two simple principles; first, that in their peroxyds, the metals replace hydrogen in two-thirds their ordinary equivalent, and second, that the molecules of a compound are divisible to an unlimited extent, we may reduce all the mineral silicates to a few simple forms.*

In the calculation of a formula like the above, it is necessary to keep in view this divisibility of molecules and also the fact that H, Mg, Alβ, Fe, Feβ, K, and other metals, may replace each other to any extent. The FeβO and MgO, which in the calculation are for convenience represented together, supply in the mineral the deficiency which appears in the quantity of water, as well as the fractional equivalent assigned to the alumina.

The mineral above described, from its hardness and specific gravity is evidently to be referred to the order *zeolite*. In its density it approaches datholite and prehnite, to which it is much inferior in hardness, while from the rare species, edingtonite, to which in hardness and density it is closely allied, it is distinguished by its crystallization. Under these circumstances, I offer it as a new mineral species which will take a place by the side of edingtonite; and to connect with his favorite science, the name of one who is among its most successful cultivators, I propose for it the designation of *Algerite*.

Montreal, C. E., May 5th, 1849.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Fatty Acids of Castor Oil;* by M. Saalmüller, (Chem. Gazette for Feb., 1848; from Liebig's Ann., lxiv, p. 108.)—The author has submitted to examination the products of the saponification of castor oil, and has corrected the results of Bussy and Lecanu, pointing out the probable sources of error in their investigations. According to him, the oil yields beside glycerine, a mixture of a fluid fatty acid with a crystalline one which may be separated by cold. When purified, so as to burn without residue, it had the melting point and composition of *stearic acid*. Another specimen of the oil furnished a solid acid which

* Compt. Rendus de l'Acad., t. xxiii, p. 1050, et t. xxiv, p. 94. See also Am. Jour. of Science, vol. v, p. 405.

resembled palmitic acid, but differed in its melting point which was constant between 140°–144° F.

The fluid portion could not be separated into different acids as MM. Bussy and Lecanu had found; its lead salt was almost entirely soluble in ether. This solution decomposed by hydrochloric acid, furnished an oily acid which was obtained pure by the process employed by Guttleib in his fine researches on oleic acid. This consists in combining it with ammonia and precipitating with chlorid of barium; the baryta salt is dissolved by a very gentle heat in strong alcohol, and is deposited on cooling in granular crystals which are purified by repeated crystallizations. In this way a salt of constant composition is obtained, which by decomposition yields an acid to which the name of *ricinoleic* is applied. It forms a syrupy liquid, inodorous, but having a disagreeable acrid taste. Its sp. gr. at 59° F., is ·940; between 14° and 21° it forms a granular mass; it mixes in all proportions with alcohol and ether, and the solutions have an acid reaction, decomposing the alkaline carbonates. It does not absorb oxygen from the air; it is decomposed by distillation, but neither in the resulting product nor in those of the distillation of the oil itself, could sebacic acid be detected. The composition of this acid, as determined by its analysis and that of its various salts, is represented by the author as $C_{38}H_{35}O_5+HO=C_{19}H_{36}O_3$. T. S. Hunt.

2. *On Taurine and a substance isomeric with it;* by J. Redtenbacher, (Liebig's Ann., Jan., 1848.)—When taurine is dissolved in caustic potash and the solution cautiously evaporated to dryness, all the nitrogen is evolved as ammonia without any carbonization of the mixture. On dissolving this in water and distilling with dilute sulphuric acid, the distillate contains along with sulphurous, acetic acid, and only sulphate of potash remains in the retort. Taurine, which has the formula $C_4H_7NO_6S_2$, contains the elements of one equivalent of aldehyde, one of ammonia, and two of sulphurous acid; the metamorphosis under the oxydizing action of potash is therefore easily understood. M. Redtenbacher was hence led to expect the artificial formation of taurine, by passing sulphurous acid gas in a carefully cooled solution of aldehyde-ammonia in alcohol. When the solution becomes acid, it begins to deposit a white crystalline substance which when washed with alcohol and dried in a vacuum, forms delicate needles that have an acid reaction, and show by the action of acids and alkalies the presence of sulphurous acid, ammonia and aldehyde. It is readily decomposed by exposure to the air, and is very soluble in water and dilute alcohol, but the solutions on evaporation evolve sulphurous acid, and the salt cannot be obtained again from them. Its analysis as well as its reaction, show that it is a *bisulphite of aldehyde-ammonia.* $C_4H_4O_2, NH_3+2SO_2=C_4H_7NO_6S_2$. It is consequently isomeric with taurine, and as the author observes, may differ from it as cyanate of ammonia does from urea. T. S. H.

3. *On Carbothialdine, a new organic base;* by Prof. J. Redtenbacher and Prof. J. Liebig.—The derivatives of aldehyde-ammonia, have already embraced two new alkaloids besides the isomere of taurine [above described]. In addition to these the present memoir has made us acquainted with a new sulphureted alkaloid, to which the authors

have given the name of *carbothialdine.* When pure aldehyde-ammonia is dissolved in alcohol and sulphuret of carbon added, the mixture loses its alkaline reaction, becomes warm, and in a few minutes deposits shining white crystals, which when washed with alcohol are pure carbothialdine. It is nearly insoluble in water, and cold ether and alcohol, but dissolves in boiling alcohol, and is deposited on cooling without change. When oxalic acid and ether are added to the solution, an oxalate of carbothialdine is deposited in slender white needles. The new base dissolves in muriatic acid and forms a hydrochlorate, which is slowly decomposed at the ordinary temperature, and by boiling, is resolved into sulphuret of carbon, chlorid of ammonium and aldehyde.

The formula deduced from analysis is $C_5 H_5 NS_2$, and it is derived from the elements of one equivalent of aldehyde-ammonia, and one of bisulphuret of carbon, by the abstraction of the elements of two equivalents of water.

[This new alkaloid is isomeric with pyrotartaramid, which is a homologue of oxamid, but the results of decomposition by acids show that in constitution it is not allied to the pyrotartrates.] T. S. H.

4. *On the action of Chlorine upon Benzoate of Potash;* by E. St. Evre, (Chem. Gazette, April 15th, 1848; from Compt. Rendus, vol. xxv, p. 912.)—When chlorine gas is passed into a strong alkaline solution of benzoate of potash, an abundant disengagement of carbonic acid gas takes place after some time, with the formation of chlorid of potassium, indicating a partial oxydation of the benzoate. The result of this is a new acid which is separated from the potash salt by sulphuric acid; it is volatile and crystallizable, and fuses between 176° and 182°. Its analysis, with that of its silver salt, lead to the formula $C_{12} H_5 Cl O_4$ or $C_6 (H_5 Cl) O_2$ in M. Gerhardt's notation, evidently corresponding to a normal species $C_6 H_6 O_2$, which differs from phenol (carbolic acid) as acids do from aldehydes, by one equivalent of oxygen; this unknown species the author has designated as phenic acid, and the present compound is mono-chlorophenic acid. Like the analogous monobasic crystallizable acids containing O_2, it should yield by the action of caustic alkalies a hydrocarbon *phenylene.*

M. St. Evre has obtained the mono-chlorinized species, $C_5 (H_5 Cl)$. This by the action of nitric acid affords a nitric species $C_5 (H_4 Cl NO_2)$, which by the action of hydrosulphuret of ammonia is converted into a chlorinized alkaloid $C_5 (H_6 Cl) N$ which corresponds to nicotine. If then we could by the action of an amalgam of potassium upon chlorophenic acid obtain the normal compounds, it would enable us to form nicotine artificially. T. S. H.

5. *On the identity of Picric, Nitrophenisic and Chrysolepic Acids,* (Jour. de Pharmacie, Oct. 1, 1848, p. 318.)—This long disputed question has at last been settled by Prof. Marchand, by the careful examination of their salts as well as a crystallographic examination of the crystals of chrysolepic and picric acids, which Mitscherlich has shown to be identical in form. These results are further confirmed by the conclusion of M. E. Robiquet, deduced from the study of their lead-salts. T. S. H.

6. *On the analysis of some of the Sulphur Acids;* by MM. Fordos and Gelis, (Annales de Chim. et de Phys., Jan., 1848.)—The process for the analysis of some of the lower sulphur acids, by means of chlorine, is not only tedious but liable to error when the acids are readily decomposed. The use of standard solutions having suggested itself to the authors—they tried permanganate of potash and chlorid of gold without success, but at last found every thing that could be wished in the hypochlorites used as decomposing agents.

All the lower sulphur acids, with the single exception of the hyposulphuric, are immediately oxydated by the hypochlorites, and an excess of the reagent is not required.

Dilute solutions of potash or soda saturated with chlorine—hypochlorite of soda obtained by double decomposition or even solution of chlorid of lime will answer for the reagent. Hyposulphite of soda, being easily obtained in a state of purity, answers perfectly as a test of the strength of the reagent—1 part of this salt requires for its oxydation 1·14 of chlorine—the liquid containing this quantity may occupy 50 divisions of the volumeter.

About 1½ gr. of the salt to be analyzed should be dissolved in 1000 times its weight of water—when the decomposition is complete, the smell of the hypochlorite is considered a sufficiently accurate test of excess. The divisions then are to be read off and give at once the quantity of chlorine used. Indigo may be used as in ordinary chlorometric analysis—but in this case the liquid should be acidulated or the indigo may be attacked in preference to the sulphuric acid. If the solutions are neutral, some of the hypochlorite should be added before the acid.

This mode of analysis is suggested as suitable for the lower acids of phosphorus, arsenic and antimony, &c. Hyposulphite of soda is also proposed as a substitute for arsenious acid in ordinary chlorimetry.

G. C. Schæffer.

7. *Ink for Steel Pens;* by M. Runge, (Polyt. Jour. in Chem. Gaz.)—Ten parts of logwood are to be exhausted with eighty of boiling water. To the solution one thousandth of its weight of yellow chromate of potash is to be gradually added—the liquid turns brown and at last blue black—no gum is needed, and the ink is not removed by soaking in water. G. C. S.

8. *On the Application of Liquid Hydrocarbons to Illumination;* by C. B. Mansfield, (Chem. Gaz., May, 1849.)—The fluid called by the author benzole, obtained from coal, tar, or any other volatile hydrocarbon, may be used for this purpose. Through this liquid is to be conducted common air or steam passed over coke, when the air or gas so treated becomes fitted for burning, and gives out a clear white light. Some precautions are to be taken to prevent the evaporation of the fluid, from lowering its temperature below that of the air, which ordinarily is the proper temperature for the fluid. When common air is used, the holes must be larger than in gas jets. The advantages of this mode of illumination are simplicity of apparatus, perfect cleanliness and safety, and great brilliancy of the light. Several years since an apparatus on the same principle was exhibited in this country—spirits of turpentine were

wholly or in part used. The light seemed equal to that from an equal number of gas jets, and was remarkably white. G. C. S.

9. *On a new Acid of Sulphur;* by MM. Fordos and Gelis, (ibid.)—M. Plessy has recently announced the discovery of several new sulphur acids, but the uncertainty of the analysis left a doubt upon their existence. These acids were supposed to be formed by the reaction of sulphurous acid in solution upon proto- and perchlorid of sulphur. In the present memoir it is conclusively shown that the product is the same in both cases, and if time for spontaneous decomposition is not allowed, the salts of the new acid (and there is but one) may be obtained in a state of almost perfect purity.

To a given quantity of solution of sulphurous acid, one-tenth its weight of perchlorid of sulphur is to be added—the solution, evaporated to one half, is to be saturated with carbonate of lead, to remove sulphuric and hydrochloric acids. The chlorid of lead in solution is thrown down by alcohol. The lead is next precipitated by sulphuric acid and the liquid filtered and saturated by the carbonate of barytes. The filtered barytic solution precipitated by absolute alcohol furnishes the new salt. The salts of this acid are $S_5 O_5$ MO. The same formula was assigned by Wackenroder to a sulphur acid formed by the action of sulphureted hydrogen upon solution of sulphurous acid,—although no analysis was made, it now appears that the formula is correct and that the same acid is formed under these very different circumstances. This acid completes the series containing 5 equivalents of oxygen, for which apart from theoretical considerations, Messrs. F. and G. propose retaining the names proposed by Berzelius. We have then—

Dithionic acid,	$S_2 O_5$	hydrosulphuric acid of Gay Lussac and Walter.
Trithionic	$S_3 O_5$	sulpho-hyposulphuric of Sanglois.
Tetrathionic	$S_4 O_5$	first acid of Fordos and Gelis.
Pentathionic	$S_5 O_5$	new acid of " "

The pentathionate of baryta is white, and can hardly be distinguished from the tetrathionate, but by analysis—it is however more soluble and more easily decomposed; a solution of it is precipitated yellow by nitrate of suboxyd of mercury. Chlorine and hypochlorites transform it at once into sulphate; permanganate however retains its color and only decomposes in presence of much acid. Iodine is not taken up by it. Heat evolves sulphur and sulphurous acid and sulphate of baryta remains. The dilute free acid is very alterable, acid and bitter, and reddens litmus.

The baryta salt contains 2 equiv. water, which may be wholly or in part replaced by alcohol.

The new acid, it is to be remarked, is isomeric with the hyposulphurous ($S_2 O_2$), but its capacity of saturation, &c., is very different.

In conclusion the authors remark that while studying the chlorids of sulphur, they have ascertained that they correspond in composition with the acids of the thionic series—taking Cl for O. G. C. S.

10. *On a new Borate of Soda;* by Dr. P. Bolley, (Liebig's Ann., Oct., 1848, in Chem. Gaz.)—The evolution of ammonia from the mixed

solutions of borax and sal-ammoniac led to the suspicion that a new borate of soda might be formed.

One equivalent of chlorid of ammonium and two equivalents crystallized borax were dissolved and boiled as long as ammonia was disengaged. The filtered solution was evaporated very slowly—the first crops of crystals were borax and the syrupy residue afforded no more crystals—however by very slow evaporation and recrystallization, hard milk-white shining but minute crystals were obtained. This salt contains much water, but does not puff up so much as borax by heat. It is soluble in 5 or 6 parts of water at common temperatures. The solution is neutral to tumeric and litmus paper.

The formula furnished by analysis is $4BO_3$, NaO+10HO.

[The proportion of acid and base is the same as in the salt said to be formed by combining borax with as much acid as it already contains.]

The reaction of chlorid of ammonium with borax furnishes the author with a very plausible theory for the formation of native boracic acid. He has found that boracite and datholite have the same reaction as borax. Tourmaline, axinite and other minerals however contain boracic acid. In a volcanic region, sal-ammoniac is abundant, and in contact with any of these minerals, free boracic acid will be produced. An excess of sal-ammoniac will set free all the acid, as it does with borax. The evaporation of the acid with the steam, &c., is well known; hence we have all the conditions for the formation of the lagoons of Tuscany.

This theory is confirmed by the observations of Payen, that ammonia was found by him in the vapors collected at Monte Rotundo in Tuscany. G. C. S.

11. *Solubility of Chlorid of Silver in Hydrochloric Acid.*—M. J. PIERRIE states that hydrochloric acid dissolves $\frac{1}{200}$th of its weight of chlorid of silver, and when diluted with twice its weight of water it still retains $\frac{1}{600}$th. G. C. S.

12. *Analysis of Phosphates of Manganese;* by M. W. HEINTZ, (Jour de Ph. et de Ch., Nov., 1848, in Phil. Mag.)—Phosphate of manganese, a salt of manganese precipitated by phosphate of soda and dissolved in phosphoric acid, yields, on evaporation, small prismatic crystals, very soluble in water, insoluble in alcohol.—Formula PO_5 MnO+2HO+2HO. The water goes off between 230° and 248° F.

Trisphosphate of manganese, obtained by precipitating sulphate of manganese with phosphate of soda, is a white amorphous powder, very little soluble. Formula PO_5 3MnO+3HO+4HO. 4 equivs. of water expelled between 230 and 248° F., the remainder by calcination.

Ammonia-diphosphate of manganese obtained by adding gradually a solution of sulphate of manganese with ammonia and sal-ammoniac, to an ammoniacal solution of phosphate of soda; the viscid precipitate is converted into crystalline scales. Formula PO_5 2MnO NH_3 3HO.

Diphosphate of manganese—final permanent precipitate from acid solution of sulphate—a reddish crystalline mass, but little soluble in water, readily in acids. Formula PO_5 2MnO HO+HO+5HO. 5 equivs. water expelled below 248° F., 1 at 392° and 1 by calcination. G. C. S.

13. *Phosphate and Pyrophosphate of Lime;* by W. Baer, (Poggendorff's Ann. in Chem. Gaz.)—The ordinary phosphate is obtained crystallized by solution of phosphate of soda made strong by acid with acetic acid; precipitated with chlorid of calcium, it is PO_5 2CaO, HO+ 4HO. A part of the water is expelled at 302°, but the remainder only at a red heat.

Pyrophosphate of soda with acetic acid precipitated with excess of chlorid of calcium, gives a crystalline pyrophosphate of lime PO_5 2CaO+4HO. The preceding salt prepared with excess of pyrophosphate of soda always contains soda, and by prolonged digestion, a well defined double salt is obtained which is PO_5 CaO, NaO+4HO.

G. C. S.

14. *Process of extracting Nickel and Cobalt followed in a Manufactory at Birmingham;* by M. Louyet, (Chem. Gazette, April 16, 1849, p. 165; from Bullet. de l'Acad. Royale de Belgique.)—The ore employed in this manufactory is obtained from Hungary. It consists principally of metallic sulphoarseniurets, and contains generally 6 per cent. of nickel and 3 per cent. of cobalt. These proportions however vary.

The ore is mixed with a small quantity of carbonate of lime and fluor spar, and the whole heated to a white-red in a reverberatory furnace; the mass fuses at this high temperature, and a slag is obtained floating on the surface, which is removed, and a fluid mass of metallic appearance; the latter is let out of the furnace by a particular aperture, and watered in order that it may be broken into fragments with greater facility. It has been ascertained from experience that when the slag is of a dull color, it contains iron; but if its surface is black and brilliant, it is free from it. The metallic mass is reduced to a very fine powder, which is then calcined at a bright red in a furnace, graduating the temperature so as to avoid fusion, and constantly raking it: a considerable quantity of arsenious acid is driven off. The air has free access to the mass, which becomes oxydized and diminishd in weight. The calcination, which lasts for about twelve hours, is continued until no more white fumes are given off, and the residue is treated with hydrochloric acid, which dissolves nearly the whole of it; the liquid is diluted with water, and milk of lime and hypochlorite of lime (chlorid of lime) added,* when a precipitate falls, which after being well washed is thrown away. A current of washed sulphureted hydroden, generated from sulphuret of iron and dilute sulphuric acid, is passed into the liquid until it is saturated; it is discontinued when some ammonia, added to a sample of filtered liquid, gives a black precipitate; if there was not an excess of sulphureted hydrogen, the precipitate produced by ammonia would be green. The sulphureted hydrogen causes a precipitate in the liquid; it is washed, and as it is slightly soluble, a current of sulphureted hydrogen is passed into the wash-waters. The precipitate is thrown away. The cobalt is then thrown down with a solution of hypochlorite of lime. The precipitate, washed,

* The lime and hypochlorite of lime are added to precipitate the iron and arsenic; the hypochlorite, by peroxydizing the iron, admits of its being precipitated by the lime.

dried, and then heated to redness, is considered to be oxyd of cobalt, and part is sent in this state into the market; another portion is heated to a white-red; by this treatment the oxyd loses in weight, but increases in density; it is sold as protoxyd of cobalt. The liquid from which the cobalt has been precipitated is treated with milk of lime, which precipitates the nickel in the state of hydrate; this precipitate is washed, dried and heated to redness; it is then mixed with charcoal, and by means of a strong heat reduced to the state of a spongy nickel, which is employed in the manufacture of German silver. With respect to the oxyd of cobalt, nearly the whole of it is consumed in the Staffordshire potteries. The oxyd of cobalt thus prepared is remarkably pure.

15. *On Liquid Protoxyd of Nitrogen;* by M. DUMAS, (Compt. Rend., Nov. 6, 1848; Phil. Mag., xxxiv, 153, Feb., 1849.)—M. Natterer of Vienna has constructed a forcing-pump for the liquefaction of gases, by means of which carbonic acid and protoxyd of nitrogen can readily be obtained in the liquid state. Having procured one of these instruments, and employed it more especially for the liquefaction of the protoxyd of nitrogen, I soon perceived the necessity of using a series of indispensable precautions, but which, once adopted, have enabled me to effect with promptitude and security, as well as economy, the liquefaction of large quantities of protoxyd of nitrogen.

As this liquid furnishes a means of producing an excessively low temperature, and is very easily operated with, I will here briefly point out the observations I have made. The first relates to the principal piece of the apparatus, that is to say, the reservoir. In my opinion the Viennese manufacturer has not given it sufficient strength. I have had it surrounded with a belt of forged iron, capable of resisting 800 atmospheres, and very nicely made by M. Bianchi. Moreover, I have arranged things so that the reservoir being surrounded by ice, the body of the pump was cooled uninterruptedly by a circulation of water around it, and that even the stem of the piston was always moistened by cold water; in this manner there is no danger of the valve of the piston being injured by the heat proceeding from the compressed gas, and by its special action as a combustible gas. With these precautions, we may compress into the reservoir in the course of two hours 200 litres of gas, of which 20 suffice to produce a pressure of 30 atmospheres, about which, liquefaction commences. The remainder of the gas furnishes a liquid; 100 litres yield 200 grms., or very nearly. The gas should be absolutely dry in order to succeed, and likewise as pure as possible. I prepare it from the nitrate of ammonia as usual, and after having dried it, pass it into Macintosh bags; a couple of pounds of nitrate of ammonia suffices.

Once compressed, the liquid gas may be preserved for one or two days at least in the reservoir; the valve however is slightly injured by it. When the stopcock of the reservoir is opened, the gas escapes; a portion freezes at first, but it then flows liquid; the solid portion resembles a mass of snow; it melts upon the hand, and rapidly evaporates, leaving a severe burn. The liquid portion, which is by far the most abundant, and of which it is easy to obtain in one operation 40 to 50 grms., being received in a glass, keeps for half an hour, or even more, in the air.

In order to observe more readily its properties, I collected it in open tubes, contained in vessels at the bottom of which was placed some pumice-stone moistened with sulphuric acid. It then retains its transparency for a very long time.

The protoxyd of nitrogen is liquid, colorless, very mobile and perfectly transparent; each drop that falls upon the skin produces a very painful burn. The gas, which is incessantly liberated by slow ebullition, possesses all the properties of the protoxyd of nitrogen. When metals are dropped into this liquid, they produce a noise like that of red-hot iron immersed in water. Quicksilver causes the same noise, instantly freezes, and affords a hard brittle mass, white like silver, which it perfectly resembles in appearance. Potassium floats upon the liquid, and experiences no change; the same is the case with charcoal, sulphur, phosphorus and iodine. Ignited charcoal floats upon the surface of the liquid, and burns with considerable brilliancy, and frequently until the whole is consumed. Ordinary sulphuric acid and concentrated nitric acid freeze immediately. Ether and alcohol mix with the liquid without freezing. Water is instantly converted into ice; but it produces such a sudden evaporation of a portion of the liquid, that it causes suddenly a kind of explosion, which would be dangerous if merely a few grammes of water were poured at once into the liquid.

16. *On a new Product of the dry Distillation of Amber;* by L. F. Bley and E. Diesel, (Chem. Gazette, April 2, 1849, pp. 142, 143; from Archiv. der Pharm., lv, p. 171.)—This substance, which resembles wax, was obtained in some experiments variously modified in order to obtain the largest possible amount of succinic acid from amber. In one of these experiments 32 oz. of amber were mixed with 2 oz. of crude concentrated muriatic acid, which had been previously diluted with an equal amount of water, and submitted to distillation in a glass retort. By accident a very brisk fire was made. When the operation was finished, a yellow wax-like substance was found in the neck of the retort mixed with the sublimed succinic acid. A somewhat loose cinder remained in the retort instead of the colophony; it weighed 3 oz., whilst the quantity of oil was very considerable, viz., 21½ oz.; whilst in the usual mode of distilling, generally only between 4 and 5 oz. of oil are obtained from 16 oz. of amber. The amount of succinic acid was 1½ oz.

The wax-like substance was well washed and purified by being melted in water and solution in absolute alcohol. In thin layers it is yellowish, in large masses brownish-green, lighter than water, soft, transparent or opake, melting between 185° and 187°, boiling somewhat above 572°, and void of taste and smell. It is insoluble in water, readily soluble in alcohol and ether, fats and liquid oils, and burns with a strong luminous flame. The analysis of the substance dried over chlorid of calcium furnished—

Carbon, - - - - -	86·123	1 = 6	85·7
Hydrogen, - - - -	13·691	1 1	14·3

From the properties and composition of this substance, it agrees with a body found near Merthyr Tydvil, in England, in narrow veins, with quartz, calcareous spar and iron ores, at Loch Fyne, in Scotland,

and at Seamick in Moldavia, in layers of bituminous schists, and is described with the same properties by Oken under the name of ozocerite (Hatchetine.) The authors however are of opinion that the muriatic acid used for these experiments has no influence on the production of this wax-like substance, which the authors have provisionally called artificial ozocerite.

17. *On the Action of Chloroform on the Sensitive Plant* (*Mimosa pudica*); by Professor MARCET of Geneva, (read before the Société de Physique et d'Histoire Naturelle, Oct. 19, 1848, and communicated by the author to Phil. Mag., xxxiv, 130, Feb., 1849.)—When one or two drops of pure chloroform are placed on the top of the common petiole of a leaf of the sensitive plant, this petiole is seen almost immediately to droop, and an instant after the folioles close successively pair by pair, beginning with those which are situated at the extremity of each branch.* At the end of one or two minutes, sometimes more, according as the plant is more or less sensitive, most of the leaves next to the chloroformed leaf and situated beneath it on the same stalk, droop one after another, and their folioles contract, although generally in a less complete manner than those of the leaf placed in immediate contact with the chloroform. After a rather long time, varying according to the vigor of the plant, the leaves open again by degrees; but on trying to irritate them by the touch, it is seen that they have become nearly insensible to this kind of excitement, and no longer close as before. They thus remain as torpid for some time, and generally do not recover their primitive sensitiveness till after some hours. If, however, when they are in this state of apparent torpidity, they are subjected again to the action of the chloroform, they close as they did the first time. It is not till after they have been chloroformed several times, that they lose all kind of sensitiveness, at least until the next day; sometimes they even fade completely at the end of too frequent repetitions of the experiment. In all cases the effects observed are the more marked in proportion to the purity of the chloroform employed and the degree of sensitiveness in the plant.

An analogous phenomenon is produced if, instead of placing the drop of chloroform on the base of the petiole, it is laid on the folioles situated at the extremity of a branch. The folioles of this branch immediately begin to close pair by pair, the common petiole droops, lastly the folioles of the other branches close in turn. At the end of two or three minutes, the nearest opposite leaf, and if the plant is vigorous, most of the other leaves situated below on the same stalk follow their example. When, after some time, the leaves open again, the same want of sensitiveness is manifested as in the preceding case.

A singular feature in this phenomenon is the manner in which the action of the chloroform is propagated from one branch to another, then from one leaf to another, even when the liquid disappears by evaporation almost as soon as it is deposited. This action, as we have just seen, appears to be communicated from the leaf to the stalk, following in the latter a descending direction; generally the leaves situa-

* I previously convinced myself by experiment that a drop of water, placed delicately on a leaf of the sensitive plant, caused no movement.

ted above the chloroformed leaf are not at all affected. DeCandolle, in making an analogous experiment on a sensitive plant with a drop of nitric or sulphuric acid, remarked on the contrary, that it was the leaves above the leaf touched which closed, without those situated beneath participating in this motion.* The observation of our learned countryman is quite naturally explained by attributing to the ascending sap the transport of the corrosive poison, a transport which, in this case, would take place in the direction from below upwards. But how to account for the apparent transmission of the effects of the chloroform in the contrary direction, from above downwards? Might the descending sap more peculiarly have the property of transmitting the narcotic effects of this singular compound from one part of the sensitive plant to the other; or might there exist in this plant some special organ susceptible of being affected by certain vegetable poisons in a manner analogous to the nervous system of animals? Notwithstanding the interesting investigations of Dutrochet and other physiologists, there still prevails too much obscurity on this subject to hazard an opinion. But in any case the fact is singular, and appears to me to merit the attention of persons accustomed to engage in questions of this nature.

Experiments of the same kind, made on the contractility of the sensitive plant with rectified ether, have furnished me results nearly similar to the preceding; with this difference, however, that whilst one drop of chloroform placed on the common petiole of a leaf situated at the extremity of a branch of a sensitive plant suffices to cause most of the other leaves situated beneath on the same branch to close, ether in general produces an effect only on the leaf itself with which it is put in contact. The next leaves have generally appeared to me not affected. I must however add, that my experiments with ether having been made after others, and at a time of year when the sensitiveness of the plant had already begun to diminish, it is possible that the intensity of the effects produced may have thereby been affected.

18. *Analysis of the Water of the Mediterranean on the Coast of France*, (Phil. Mag., May, 1849, xxxiv, 398; from Comptes Rendus, Oct., 1848.)—M. J. Usiglio analyzed the water from the foot of Mount St. Clair, about 400 metres from the port of Cette.

100 parts gave—

Chlorid of sodium,	2·9424
Bromid of sodium,	0·0556
Chlorid of potassium,	0·0505
Chlorid of magnesium,	0·3219
Sulphate of magnesia,	0·2477
Sulphate of lime,	0·1357
Carbonate of lime,	0·0114
Peroxyd of iron,	0·0003
Water,	96·2345
	100·000

19. *Impurity of Commercial Bromine*, (Phil. Mag., May, 1849, vol. xxxiv, p. 399; from Journ. de Ph. et de Ch., Février, 1849.)—M. Po-

* DeCandolle, *Physiologie Végétale*, vol. ii, p. 866.

SELGER, in distilling some samples of commercial bromine, found that the boiling-point was not 122° F., but 248° F.; and that the color of the liquid became gradually lighter, till it was eventually quite colorless. On continuing the distillation to dryness, he obtained a residue of charcoal. On separating the bromine from the last portions of the distilled liquid by means of a solution of potash, an aromatic, oily, colorless liquid was obtained, which analysis proved to be carburet of bromine; this existed in various specimens of bromine to the extent of 6 or 8 per cent., and there is every reason to conclude that it was derived from the ether employed in the prepartion of this substance.

20. *Method of Soldering cast-iron with wrought-iron*, (Technologiste; Lond. Jour. and Repert., vol. xxxiv, p. 280.)—The following process has been recommended for this purpose:—First melt filings of soft cast-iron with calcined borax in a crucible; then pulverize the black vitreous substance which is thereby produced, and sprinkle it over the parts which are intended to be united; after which, heat the pieces of cast and wrought-iron and weld them together on an anvil, using only gentle blows. This method is peculiarly applicable for the manufacture of iron articles which are intended to be made red hot, and are required to be impervious to fluids or liquids; as such a result cannot be obtained by simple fastening.

21. *Mode of Silvering Glass by the employment of Gun-Cotton*, (ibid.)—M. VOHL has recently discovered that a solution of gun-cotton in a caustic ley, possesses, in a high degree, the property of precipitating silver from its solutions in the metallic form. In fact, on bringing gun-cotton into contact with a caustic ley of sufficient strength, the cotton will become dissolved in the ley, giving out ammonia with a considerable degree of heat, and producing a deep brown liquor, somewhat thick: on pouring an acid into this, a brisk effervescence is produced, carbonic acid and nitrous acid being disengaged.

The action of gun-cotton, in this instance, shews that it is not simply dissolved, but undergoes decomposition, by which the atoms of oxygen, in the nitric acid, enter into combination with the atoms of carbon in the cotton, thus producing carbonic acid, which as well as the nitrous acid produced by the nitric acid, combines with one part of potash. A fresh decomposition of nitrous salt by the potash, in presence of hydrogenated substances, furnishes ammonia.

The most remarkable property of this alkaline solution is the following:—On pouring into it a few drops of a solution of nitrate of silver, and adding ammonia until the oxyd of silver formed is re-dissolved (the mixture being slowly heated in a water bath), the liquor will, at a certain period, assume a deep brown color and effervesce, the whole of the silver being precipitated on the sides of the vessel. The mirror thus produced is much superior in brilliancy to those produced by means of etherial oils or ammoniacal aldehyde; and the facility with which it is produced will doubtless render it of practical importance.

This property is not exclusively possessed by gun-cotton; it is found also in cane sugar, sugar of milk, manna, gums, and other substances which may be rendered explosive by treating them with nitric acid. Picro-azotic acid produces, under the same circumstances, a reflective

metallic surface; and it appears that this reaction takes place with all bodies which, when treated with nitric acid, do not furnish products of oxydation, but another series of bodies that admit of carbonic acid forming one of their constituent parts, since they at the same time give up an equivalent of water.

22. *On a Mode of rendering Substances incombustible;* by ROBERT ANGUS SMITH, Ph. D., Manchester, (Phil. Mag., xxxiv, 116, Feb., 1849.)—I have often been surprised that, considering the number of materials which will not burn and the small number which do burn, we should be compelled to build houses so liable without constant watchfulness to instantaneous destruction; that we should go also to sea in vessels made of a most combustible substance filled with enormous fires, frequently under the care of ignorant men. I think, therefore, I may be excused when I endeavor to add to a knowledge of the mode of rendering substances incombustible, or the theory of the mode to be sought after, even if the addition which I make be but a very small one.

Silicate of potash has been considered good. It is a soluble glass which was expected to cover the fibre of cloth or wood, and so protect it from heat. This does act to some extent, probably in the same manner as stones do when put into a fire of wood or coal; they take heat but give none, and are also bad conductors. If silicate of potash remained as a glass, it would act also by keeping out the air; but this does not seem to be the case, as it falls after a time to a powder.

It struck me that the mode of preventing combustion was not by protecting the wood from the fire merely, as heat must cause combustible gases to rise from wood, whether there be incombustible substances mixed with it or not, and these gases will force their way to the surface where there is no longer any preventive to burning. My object then was to find a substance which would render the wood unfit to burn, and would cause it to give out gases which would not burn; so that whilst the wood itself was being preserved, except where in contact with the fire, the gases would assist in extinguishing the fire.

I first tried phosphate of magnesia and ammonia, thinking the ammonia given out would be of use in extinguishing the fire; but this was of no value, as a piece of calico required to be made quite stiff with it before it was rendered incombustible. The calico was prepared by dipping it in a solution of phosphate of magnesia in muriatic acid and then in ammonia. It seemed to me that the earthy salts are of little use for the purpose required, and that the amount of solid matter incapable of evaporation left on the cloth, assists in a very small degree.

Sulphuric acid, however, seemed to present the most promising characteristics of a substance incapable of burning, and of acting so strongly on vegetable substances as to make them incapable of burning. Sulphuric acid itself is a body perfectly burnt, or we may say overburnt, having an atom of oxygen given to it by artificial means, so to speak, which atom is difficult to separate, and therefore not resembling the oxygen of many highly oxydized bodies. It requires a high degree of heat to raise it to vapor; and the vapor formed is sluggish and heavy, remaining long where formed, and quenching flame wherever it is. It destroys the texture of wood also and other vegetable substances, caus-

ing them to give out after a time gases which do not burn, mixed with some which do burn; but if there be enough of acid, forming a mixture which does not burn. The wood also cannot be again induced to become combustible until it be heated to redness, so as to remove all the sulphuric acid, leaving only charcoal.

If sulphuric acid then could be introduced into wood just at the time that the fire was going to take place, the fire would cease to take place; and this we can do easily by saturating the wood with sulphate of ammonia. When there is no fire present there is no sulphuric acid present, as such; but as soon as the heat rises, ammonia goes off, and sulphuric acid is instantly presented to the wood. The ammonia does not come off quite pure, it is mixed with nitrogen and sulphurous acid; and this disengagement of gases is of advantage in extinguishing fire; when the heat rises to 536°, the sulphuric acid is then left to act on the wood in part and to volatilize in part, and that which I have mentioned takes place. The outside of course would first undergo the change, and the inside would be protected by the incombustible outer part; if the fire continued to act long, the inner layer would undergo a similar change. I imagine, then, the acid acts in a double manner; it makes the wood refuse to burn and it puts out fire. As sulphurous acid is given off in this process, the action is also similar in one point of view to that of sulphur, which has long been used for putting out fire in chimneys.

I have no doubt that a house built of wood prepared in this manner might have a fire lighted on the wooden floor without danger, burning only on the spot to which the fire was limited. A ship also would be safe, even if the cinders did fall from the grate in stormy weather.

I know that muriate of ammonia has been used, and that it acts very well; but I think the sulphuric acid is superior, the ammonia being merely to keep it innocent; and other volatile base might do. I am sorry, however, that this is not perfect; its solubility in water is a great disadvantage, as it cannot be applied to clothes to be frequently washed. True, it is so cheap that it might be applied every washing where there are peculiar dangers; but if a person was standing very near the fire, the ammonia would in part be evaporated, and the acid remaining would be enough to injure the fabric. There are however cases, such as curtains, to which this could not apply, and where it would be valuable.

Sir William Burnet's liquid is chlorid of zinc: he uses it for preserving wood and canvas, and also for preventing fire. I am certainly surprised that more use has not been made of it, being as far as I have seen it, so efficient. I believe the manner in which the chlorid of zinc acts is very similar to that of sulphuric acid, destroying the organic matter on the approach of heat, and rendering it incombustible. It can be introduced into wood at a specific gravity of 2000, I believe; sulphate of ammonia cannot easily be used above 1200. By heating the solution more may be attained. Sulphate of ammonia is cheap and easily procured and used, not hurting anything with which it may come in contact, and therefore more easily managed in households.

The chlorid of zinc is said to unite with the fibre. This cannot be said for the sulphate of ammonia. It would not, however, come from

the centre of a beam of wood, even if immersed in water, as the water enters with great difficulty into wood; and the solution itself cannot be introduced without forming a vacuum in the saturated vessel, and so removing all the air from the wood.

The first time I used this solution I found a large quantity of mould formed, and indeed it contains all the elements to increase its growth. The second time the solution was boiled in an iron vessel, and no mould formed on it; on the contrary mould was destroyed by it. The sulphate of ammonia dissolves iron rapidly, and forms a double salt which is deleterious to such growths. I imagined any other metallic salt would do, and used ordinary chlorid of manganese prepared in the laboratory, which killed all such fungi rapidly, and no more have grown after standing eleven months in contact with organic matter.

I believe there are many ways in which this may be used. My wish was to find a substance suited for building fire-proof ships, and I believe this would do; at any rate the ships would be fire-proof, experience could alone tell if any other objection followed. It does not render the wood hard, heavy or brittle.

I believe it would be of the greatest advantage in mills, which now suffer so much from fire, diminishing or rather entirely removing the expense of insurance. It does not hurt colors; so that even colored goods might be dipped when kept long in one place, or when sent in vessels abroad. Possibly some delicate colors may be attacked, but this must be a rare case.

I am more desirous of seeing ships built of an incombustible material, the means of escape at sea being few, and confined to few; and whilst there is any hope of doing it easily, I scarcely think it proper for any one to neglect what information may exist on the subject.

II. Mineralogy and Geology.

1. *Randanite, a native hydrated Silica from Algiers;* by M. Salvetat, (Ann. de Ch. et de Phys., Nov., 1848, t. xxiv, p. 348.)—This hydrated silica exists abundantly near Algiers, and was taken for Kaolin. It is pulverulent and friable, forming an excessively light powder. It is infusible, but loses color and becomes grayish, contracting a little. It gives up water at 16° C., but still retains a portion at 100° C., losing the whole only at an intense heat. It was found to consist of 80 parts of gelatinous silica, 9 of water, 6·48 of insoluble silica, with 1·41 alumina, 0·55 oxyd of iron, 0·56 lime, 2·00 of potash, soda and loss, and *a trace* of magnesia. Of the water 4·04 per cent. escaped at 16° C., and 3·96 at 100° C., and 1 per cent. is combined with the alumina. Neglecting what is obviously foreign to the mineral, it has the formula $\dddot{Si}^2\,\dot{H}$ when simply dried at 16° C., and $\dddot{Si}^4\,\dot{H}$ when dried at 100° C.

The composition resembles that of a similar material from Ceyssat, and near Randan, in the Puy de Dome, analyzed by M. Fournet. This chemist obtained in his analysis, gelatinous silica 87·20, water, carbonic acid and organic matters 10·00, alumina and oxyd of iron 2·00, sand by decantation 0·80, with traces of lime, magnesia, &c.

Salvetat suggests the name *Randanite* for the mineral, in allusion to the locality, considering its composition as $\ddot{S}i^2\dot{H}$. Doveri has lately announced the formation of a substance having the composition $\ddot{S}i\dot{H}$, by the artificial drying of gelatinous silica. But the attempts of Salvetat to form Randanite artificially were not successful. A microscopic examination of the specimens from Ceyssat and Randan, has led Dufrenoy to attribute its origin to infusoria, and that of Algiers is probably due from the same source. The constancy in the composition of this infusorial silica is an interesting physiological fact.

2. *On Pistomesite and Mesitine;* by M. Breithaupt, (Pogg. Annalen, lxx, 146.)—Pistomesite resembles spathic iron. Crystallization rhombohedral; R : R = 107° 18′. Density 3·412–3·417. According to M. Fritzsche, it consists of protoxyd of iron 33·92, magnesia 21·72, carbonic acid 43·62 = 99·26, giving the formula $\dot{F}e\ddot{C}+\dot{M}g\ddot{C}$.

Breithaupt on a new examination of the Mesitine, obtained for its composition, protoxyd of iron 24·18, magnesia 28·12, lime 1·30, carbonic acid 45·76, and hence deduces the formula $2\dot{M}g\ddot{C}+\dot{F}e\ddot{C}$.

3. *Analysis of Lardite from near Voigtsberg, in Saxony;* by M. Karsten, (Jour. für Prakt. Chem., xxxvii, 162.)—Lardite, which has been referred to Agalmatolite, is an anhydrous magnesian silicate, consisting according to Karsten's analysis, of silica 66·02, magnesia 31·94, protoxyd of iron 0·81, soda and potassa 0·75, loss by ignition 0·20, chlorid of sodium and sulphate of potash, *a trace* = 99·72. It whitens before the blowpipe, and in a tube gives no trace of moisture but exhales a disagreeable odor, like many other magnesian minerals. In the exterior flame it becomes wax-yellow. It dissolves slowly but completely in borax, forming a glass which is pale yellow when hot, but becomes colorless on cooling. Density 2·795.

4. *Chemical Analysis of Glinkite;* by W. von Beck, (Verhandl. Min. Gesel. zu St. Petersburg, Jahr., 1847, p. 244.)—Glinkite comes from the District of Perm. It forms small veins in talc which is sometimes intersected by chlorite, and occurs only amorphous. The color is olive-green passing into a darker or lighter shade, and paler green by transmitted light. Luster nearly vitreous. H. = 6. G. = 3·479 at 14½° C. Fracture fine and flat conchoidal. Streak powder white. In nitric or muriatic acid it partly gelatinizes. Before the blowpipe it does not fuse, except on the edges of the thinnest splinters at a high heat.

	I.	II.	Mean.
Composition.—Silica,	38·817	39·6	39·208
Magnesia,	43·778	44·35	44·064
Protoxyd of iron,	17·141 = 99·736	17·75 = 101·70	17·445

This gives the formula $\ddot{R}^3\ddot{S}i$, in which $\dot{R} = \dot{M}g, \dot{F}e$. It is the formula of Olivine.

5. *Neolite, a new mineral;* by M. Scheerer, (Œfvers. af. K. Vet. Ak. Fœrh., iv, 70.)—Neolite is a talc-like mineral from some old mines near Arendal, Norway, where it occurs as modern incrustations in fissures

and on detached stones. It is often crystalline, either in folia, or in concentric fibrous aggregations like Wavellite. It is greenish with a greasy luster, and a specific gravity 2·77 after long desiccation. Hardness, that of talc. The analyses vary much. In one, Scheerer obtained silica 52·28, alumina 7·33, magnesia 31·24, protoxyd of iron 3·79, protoxyd of manganese 0·89, lime 0·28, water 4·04=99·85. In another, silica 47·35, alumina 10·27, magnesia 24·73, protoxyd of iron 7·92, protoxyd of manganese 2·64, water 6·28=99·19.

6. *On Völknerite, a new mineral from the mines of Schischimsk;* by M. HERMANN, (Jour. f. Prakt. Ch., xl, 11; Annuaire de Ch., 1848, p. 154.)—Völknerite occurs in white pearly laminæ on talc schist, and sometimes in hexagonal tables, with a perfect basal cleavage. Feel greasy. Density 2·04.

Composition $\ddot{\mathbf{A}}\mathrm{l}\,3\dot{\mathbf{H}}+6(\dot{\mathrm{M}}\mathrm{g},2\dot{\mathbf{H}})$.

7. *Analysis of Pyrophyllite of Spaa;* by M. RAMMELSBERG, (Pogg. Annalen, lxviii, 505.)—The analysis afforded: silica 66·14, alumina 25·87, magnesia 1·49, lime 0·39, water 5·59=99·48—leading to the formula (neglecting the lime and magnesia) $5\mathrm{SiO^3}\,2\mathrm{Al^2\,O^3}+2\mathrm{HO}$.

8. *Analysis of Talc of Rhode Island and Steatite of Hungary;* by M. A. DELESSE, (Rev. Sci. et Indust., xxv, 107.)—The Talc of Rhode Island occurs in large clear foliated masses. It has two optical axes intersecting at a small angle. Density =2·5657; after calcination =1·64. Hardness =1; after calcination =6, so that it scratches glass, although with some difficulty. It exfoliates when heated.

On analysis it afforded silica 61·75, magnesia 31·68, protoxyd of iron 1·70, water 4·83=99·96; and Delesse thence deduces the formula $2(4\mathrm{SiO^3}+3\mathrm{Mg\,O})+3(\mathrm{Mg\,O,HO})$.

This author also examined a *steatite* from Nyntsch in Hungary, and obtained for its composition, silica 64·85, magnesia 28·53, protoxyd of iron 1·40, water 5·22=100·00, this result leading to the formula $5(\mathrm{SiO^3\,MgO})+2\mathrm{HO}$.

9. *On a new Hydrosilicate of Alumina;* by MM. DAMOUR and SALVETAT, (Ann. de Ch. et de Ph., 3e ser., xxi, 376.)—This mineral occurs massive in nests in a brownish clay near Montmorillon (Vienna). It has a soapy feel, and a clear rose color, and becomes plastic in water. *Composition*, according to Damour, silica 50·04, alumina 20·16, sesquioxyd of iron 0·68, lime 1·46, potash 1·27, magnesia 0·23, water 26·00. It is hence allied to Halloysite.

10. *Philippsite and Gismondine;* by M. MARIGNAC, (Ann. de Ch. et de Phys., 3e ser., xiv, 41.)—Marignac separates these species, which Kobell and Brooke had united. Under *Gismondine* he includes specimens having an octahedral form, and rarely mammillated, and faces not striated; and under Philippsite, those whose crystals have a rectangular prismatic form terminated by a 4-sided pyramid, with the faces striated in two directions oblique to one another. Density of Gismondine 2·265, of Philippsite 2·213.

11. *On the Composition of Heulandite;* by M. DAMOUR, (Comptes Rendus, xxii, 926; Annuaire de Chim., 1847.)—Damour has detected in Heulandite a portion of soda and potash which simplifies the formula. His analysis gives: silica 59·64, alumina 16·33, lime 7·44, soda 1·16,

potash 0·74, water 14·33=99·64. Hence this mineral differs from stilbite only in the proportion of water, and it falls into the group of zeolites having the proportions

$$rO : Al^2 O^3 : Si O^3 :: 1 : 3 : 12.$$

The following table exhibits their relations,

	rO		$Al^3 O^3$		$Si O^3$	HO		
Stilbite,	1	:	3	:	12	6	in which	rO=CaO
Harmotome,	1	:	3	:	12	6	"	rO=BaO
Heulandite,	1	:	3	:	12	5	"	rO=(CaO, NaO, KO)
Epistilbite,	1	:	3	:	12	5	"	rO=(CaO, NaO)
Brewsterite?	1	:	3	:	12	5	"	rO=(SrO, BaO)
Edelforsite,	1	:	3	:	12	4	"	rO=CaO

12. *On the identity of Osmelite and Pectolite*, (Annuaire de Chem., 1848, p. 166.)—An analysis by M. Adam indicates that osmelite of Breithaupt is identical with Kobell's pectolite. He obtained for it, silica 52·91, lime 32·96, protoxyd of manganese 1·44, soda 6·10, potash 2·79, alumina and oxyd of iron 0·54, water 4·01.

13. *On Disterrite, from the valley of Fassa in Tyrol;* by M. von Kobell, (Jour. f. Prakt. Ch., xli, 154; Annuaire de Ch., 1848, 173.)—Disterrite crystallizes in hexagonal prisms, cleaving parallel to the base, and has a pearly luster on the terminal faces, with a vitreous luster on the sides of the prism. H.=5 to 6½ (Breithaupt's scale). Density 3·042—3·051. *Composition*, silica 20·00, alumina 43·22, peroxyd of iron 3·60, magnesia 25·01, lime 4·00, potash 0·57, water 3·60.

14. *On Glaucophane;* by M. Hausmann, (Jour. f. Prakt. Ch., xxxiv, 238; Annuaire de Chimie, 1846, p. 271.)—Glaucophane comes from the island of the Cyclades, and resembles indicolite. It has a prismatic foliated structure, a clear blue color seen by refraction. Density 3·103—3·113. Powder feebly attracted by the needle. The mean result of two analyses is as follows:—silica 56·49, alumina 12·23, protoxyd of iron 10·91, protoxyd of manganese 0·50, magnesia 7·97, lime 2·25, soda with traces of potash 9·28=99·63. It is near Wichtyne from Finland in composition.

15. *On Chloritoid*,* (Jour. fur Prakt. Ch., xxxiv, 454.)—MM. Erdmand and Gerathewohl have obtained for Chloritoid or Chloritic spar the formula $\dddot{Fe}^3 \dddot{\mathbf{A}}l + 2\dddot{\mathbf{A}}l \dddot{Si}$ after the following analyses.

Silica,	24·40	24·931
Protoxyd of iron,	30·29	30·047
Alumina,	45·17=99·86, Ger.	45·016=99·994, Erd.

16. *On Humite.*—Humite, according to Marignac's investigations, is identical with Chondrodite.

17. *On Epidote*, (Jour. de Pharm. et de Chim., xiv, 3d ser., Sept., 1848, p. 214.)—M. Gerhardt here cites the analyses of M. Hermann (Journ. f. Prakt. Chem., xliii, 35 and 81,) of the different varieties of Epidote, including Zoisite and Pistacite of different localities, Bucklandite, and Orthite or ceriferous Epidote. Hermann deduces from his

* Mr. J. D. Whitney has found *Masonite* to agree with Bonsdorff's analysis of chloritoid, according to which this mineral contains 5 to 6 per cent. of water. His researches are published in the Proc. Bost. Nat. Hist. Soc., April, 1849, p. 100, and will be cited in our next number.

results and those of previous chemists, that they exemplify a new principle in chemistry, which he names *heteromerism*, which is the reverse of isomorphism, it implying a similarity of crystallization with a different proportion in the ingredients. Hermann obtains for the formulas of—

Zoisite,	$3[(2RO), (Si\,O^2)]+2[2(R^2\,O^3), 3(Si\,O^2)]$
Bucklandite,	$2[(2RO), (Si\,O^2)]+[2(R^2\,O^3), 3(Si\,O^2)]$
Orthite,	$3[(2RO), (Si\,O^2)]+[2(R^2\,O^3), 3(Si\,O^2)]$

He considers Pistacite as consisting of the Zoisite type and Bucklandite type united, the green Arendal variety containing, according to him, 2 atoms of Zoisite and 1 of Bucklandite; and so on.

Gerhardt observes that M. Hermann "doubtless preoccupied with the idea that the oxyds represented by $R^2\,O^3$ cannot replace the oxyds RO in isomorphous substances, has entirely misunderstood the simplicity of relation actually existing between the varieties of epidote. If he had summed up the oxygen contained in all the oxyds and that of the silica, he would have found in all cases the simple relation of

1 : 1

In fact, in the several cases mentioned the actual relations are as follows, 2·94 : 3·03, 3·03 : 2·93, 3·01 : 3·04, 3·97 : 2·98, 2·91 : 2·87, 2·74 : 2·70, 2·74 : 2·69, 2·62 : 2·59, 2·56 : 2·55, 2·63 : 2·45, 2·05 : 2·12. All the epidotes have therefore the general formula*

$$Si^2\,O^4\,(M^4)$$

equal to $[Si^2\,O^2+2OM^2]$, "which comprises garnet, anorthite, olivine and a great number of other minerals." In epidote M^4 is represented by variable quantities of alumina and peroxyd of iron on one side, and lime, magnesia, protoxyd of iron, or of cerium on the other. Representing the former by M^β and the latter by M, the formulas of the prominent varieties are as follows:

Zoisite, ...	$Si^2\,O^4\,(M^{\beta 2\cdot 69}\,M^{1\cdot 32})$
Pistacite, ...	$Si^2\,O^4\,(M^{\beta 2\cdot 60}\,M^{1\cdot 40})$
Bucklandite, ...	$Si^2\,O^4\,(M^{\beta 2\cdot 56}\,M^{1\cdot 44})$
Orthite, ...	$Si^2\,O^4\,(M^{\beta 2}\quad M^2)$

These formulas sustain the view of the isomorphism of these minerals.

18. *On Zygadite;* by M. Breithaupt, (Pogg. Ann., lxix, 429.)—Luster vitreous. Color red and yellowish white. Feebly transparent. Density =2·511. Form of crystal a rhombic prism, and in all instances observed, macles. M. Plattner has detected in it nothing but silica, alumina and lithia.

19. *Bodenite*, (Jour. f. Prakt. Chem., xliii, 207.)—This mineral [alluded to in this Journal, vol. ii, p. 415,] has been analyzed by M. Th. Kerndt with the following result.—Silica 26·12, alumina 10·33, protoxyd of iron 12·05, yttria 3·47, lime 6·32, magnesia 2·33, protoxyd of manganese 1·61, potash 1·21, soda 0·84, protoxyd of cerium 10·46, protoxyd of lanthanum 7·56, water 3·01=99·27 : from which he deduces the formula $Al^4\,O^3, Si^3\,O^3+9R^2\,O, 2Si^3\,O^3$.

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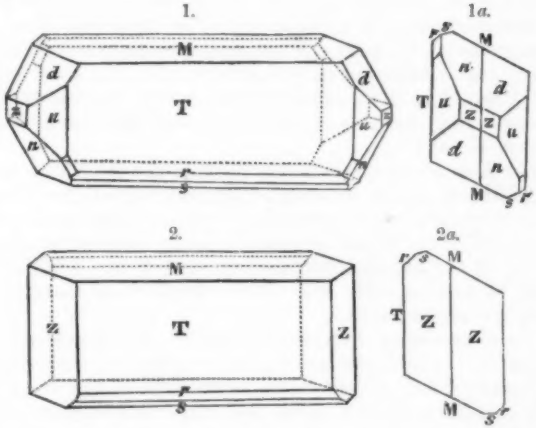
* In this formula, Gerhardt adopts his own notation, considering the oxyds OM_3, and silica $Si_2\,O_2$. The old notation is adopted in the preceding formulas.

20. *Muramontite, a new mineral;* by M. KERNDT, (Jour. f. Prakt. Chem., xliii, 207.)—Under this name the author designates a ceriferous mineral from near Marienberg in the Erzgebirge. It occurs in black amorphous grains, with a greenish reflection. Density 4·263 to 4·265. It consists of silica 31·09, alumina 2·23, glucina 5·51, yttria 37·14, protoxyd of iron 11·23, magnesia 0·42, protoxyd of manganese 0·90, lime 0·71, soda 0·65, potassa 0·17, protoxyd of lanthanum 3·53, protoxyd of cerium 5·54, water 0·82=99·94.

21. *Monazitoid, a new mineral from near Lake Ilmen;* by M. HERMANN, (Jour. für Prakt. Ch., xl, 21; Annuaire de Ch., 1848, p. 146.)—Monazitoid is a variety of monazite, hardly distinguishable in external characters, consisting of oxyd of cerium 49·35, oxyd of lanthanum 21·30, lime 1·50, phosphoric acid 17·94, substance resembling tantalic acid 6·27, water 1·36, magnesia and protoxyd of iron, *a trace*. It has thence the formula, according to Hermann, $5(CeO, LnO)\,PhO^5$, and differs from monazite in containing a tantalic substance in place of tin. Its density is 5·281.

22. *Crystallization of Uralorthite;* by N. VON KOKSCHAROV, (Verhandl. der Russ.-Kais. Min. Gesellsch. zu St. Petersburg, Jahr 1847.)—The author, in an elaborate memoir, points out close relations between the crystallization of Uralorthite, Allanite and Epidote, and shows them to be isomorphous. The following are two of his figures—from Plate iv.



The dimensions (placing *a* for the vertical axis, *b* for the clinodiagonal, and *c* for the orthodiagonal) are as follows:

Uralorthite,	$a:b:c = 1{\cdot}14918:1:0{\cdot}64510$	$\gamma=65°\ 5'$
Epidote,	$a:b:c = 1{\cdot}16050:1:0{\cdot}63653$	$\gamma=65°\ 34\frac{1}{2}'$

The description of figure 1, according to Naumann's system of notation, is as follows.

OP	$\infty P\infty$	$+P\infty$	$+\frac{1}{2}P\infty$	$+P$	$-P$	∞P	$\infty P2$
M	T	*r*	*s*	*n*	*d*	*z*	*u*

The following are some of the angles obtained for uralorthite; and in parallel columns the corresponding angles of epidote and allanite are given. The first three of uralorthite and the three measurements by the reflective goniometer, from which the dimensions were calculated.

	Uralorthite.	Epidote.	Allanite fr. *Heidinger.*	Orthite, *Scheerer.*
M : d =	127°40′	126°56¾′		
M : T =	{ 114°55′	{ 114 25½	116°	113°—116°
	{ 65°05′	{ 65 34½	64	
M : r =	116°20′	116 12½	115°	116°
M : n =	105° 1′	104 48½		
T : r =	128°45′	129 22	129°	130°48′
T : z =	125°25½′	124 57½		
T : u =	144°53½′	144 25		
d : z =	156°28′	156 45½	156¾°	

Bagrationite (Pogg. lxxiii, 182), also appears to be another variety. The measurements gave M : T=114° 55·2′; M : r=116° 35·6′; M : n =105° 10·5′; T : r=128° 29·7′; T : z=125° 25′.

The resemblance between the above minerals in composition is striking, as shown by M. Kokscharov, from a comparison of various analyses.

23. *Niobite.*—This name has been applied to the Columbite in which niobic acid is the predominant acid. Specimens from the east of Lake Ilmen have been found to agree in crystalline form with the American, as described by M. G. Rose. The mean specific gravity is 5·57.

24. *On the Yttrotantalite of Ytterby.*—M. H. Rose announces (Jour. f. Prakt. Ch., xlii, 143,) that the Ytterby yttrotantalite has the same composition, the same metallic acids, and the same density, as the tantalite of Finland.

25. *On Eukolite*, a new mineral; by M. Scheerer, (Ann. der Ph. und Ch., lxii, 561; Annuaire de Chem., 1848, p. 150.)—Eukolite appears to be a Wöhlerite, in which the greater part of the zirconium is replaced by sesquioxyd of iron. Scheerer obtained for its composition, silica 47·85, metallic acids and zirconia 14·05, sesquioxyd of iron 8·24, lime 12·06, protoxyd of cerium 2·98, soda 12·31, protoxyd of manganese 1·94, magnesia *a trace*, water 0·94.

26. *On Crystallized Pitchblende;* by M. Th. Scheerer, (ibid.)—The crystals of pitchblende are regular octahedrons with truncated angles. Density 6·71. Composition, green oxyd of uranium 76·6, oxyd of lead, metallic acids and silica 15·6, oxyd of manganese 1·0, water 4·1, loss and gangue 2·7. Scheerer does not state whether the metallic acids are essential constituents or derived from the gangue.

27. *On Euxenite from Tvedenstrand;* by M. Th. Scheerer, (ibid.) —Composition, titanic and metallic acids 53·64, yttria 28·97, protoxyd of uranium 7·58, ib. of cerium 2·91, ib. of iron, 2·60, water 4·04. Density 4·73, 4·76, 4·60. Approaches polycrase in crystalline form, crystallizing in rhomboidal prisms of about 140°, surmounted with a pyramid whose obtuse culminant edge is nearly 136°. The prism of samarskite is 135 to 136°; and the obtuse culminant edge of columbite is 150°.

28. *New Minerals;* by M. Breithaupt, (Pogg. Ann., lxix, 429.)—*Pliniane.*—This mineral has the composition and appearance of mispickel. Density =6·282. It differs from that species in being oblique in its crystallization, pertaining to the monoclinate system.

Stannine of Cornwall. This species resembles somewhat a white opaque garnet. It has little luster, a pale yellowish color, and is transparent only upon the thinnest edges. It is compact and has a scaly fracture. Hardness nearly that of quartz. Density =3·545. M. Plattner finds it to consist of silica and alumina 36·5 for 100 of oxyd of tin. It is infusible before the blowpipe.

29. *Telluric Bismuth from Brazil;* by M. A. Damour, (Annales de Ch. et de Phys., 3e ser., xiii, 372.)—This ore occurs in leaves of the luster of polished steel, slightly flexible, very tender. According to two analyses it contains—

Bismuth,	79·15	78·40	
Tellurium,	15·93	15·68	
Sulphur,	3·15	} 4·58	=98·66
Selenium,	1·48=99·71	}	

Adopting 1330·376 for the atomic number of Bismuth, as determined by Regnault and Rose, and 802·121 for the atomic weight of Tellurium, we have the formula $Bi^2S^3+3Bi^2Te$. The Schemnitz ore has the formula $Bi^2S^3+2Bi^2Te^3$; the Deutsch-Pilzen ore, BiS+2Bi Te.

30. *Analysis of Copper blende;* by C. F. Plattner, (Pogg. Ann., lxvii, 422.)—Copper blende of Haidinger is distinguished from Tennantite, by a red streak and less specific gravity. The Tennantite of Cornwall afforded Kudernatsch, copper 48·94, iron 3·57, sulphur 27·76, arsenic 19·10, silver *a trace*, quartz 0·08=99·45. Plattner has obtained for Copper Blende from Freiberg, copper 41·070, zinc 8·894, iron 2·219, lead 0·341, sulphur 28·111, arsenic 18·875, antimony and silver *traces* =99·510. Admitting that Cu^2S is isomorphous with Zn S and FeS, they have the same formula, except the substitution of Zn S in the latter for part of the Cu^2S. The formulas are—

Tennantite,	$Ar\,S^3+4(Fe, Cu^2)S$
Copper blende,	$Ar\,S^3+4(Fe, Zn, Cu^2)S$.

31. *Analysis of Phosphates of Copper from Nischne Tagilsk;* by M. R. Hermann, (Jour. f. Prakt. Chem., xxxvii, 175.)

	Oxyd of copper.	Phosph. acid.	Water.	
Libethenite,	65·89	28·60	5·50=	$PhO^5+4CuO+1\frac{1}{2}HO$
Dihydrite,	68·211	25·304	6·485=	$PhO^5+5CuO+2HO$
Phosphorocalcite,	67·15	24·55	8·20	
Ehlite,	66·86	23·14	10·00=	$PhO^5+5CuO+3HO$
Tagilite,	61·29	26·44	10·77=	$PhO^5+4CuO+3HO$

Phosphorocalcite is stated to be equivalent to equal proportions of dihydrite and ehlite.

32. *On Mendipite;* by M. Schnabel, (Pogg. Ann., lxxi, 516.)—Composition, lead 85·69, chlorine 9·87, oxygen 4·44=PbCl+2PbO.

33. *On a Native Antimonite of Mercury;* by M. Domeyko, (Berzelius's Report on the Progress of Chemistry, 6th year; Annuaire de

Chimie, 1848, 145.)—This mineral is a red powder from the mercury mines of Chili. It consists of antimonious acid 21·2 to 23·8 oxyd of mercury, with peroxyd of iron, silica and water.

34. *Arsenical Nickel from Oelsnitz;* by M. H. WACKENRODER, (Arch. f. Pharm., xcvii, 288; Annuaire de Chem., 1847, 211.)—This mineral was found in the green sand, in a gangue looking like spathic iron. The fresh fracture has a lead gray color which soon changes to brownish gray, with spots of oxyd of nickel. An analysis obtained:—Nickel 20·937, arsenic 35·258, sulphur 8·903, lead 0·299, protoxyd of iron 8·26, protoxyd of manganese 1·023, lime 12·578=87·248, the loss being carbonic acid; carbonic acid and oxyd of iron and manganese belong to the gangue. The lead is undoubtedly an unessential ingredient and exists as a sulphuret. Omitting these, the author considers the species as having the formula $NiS^2+2NiAr^2$, which would give for its composition nickel 32·700, arsenic 54·440, sulphur 11·860, the analysis affording (after separating the impurities) nickel 32·185, arsenic 54·198, sulphur 13·617.

35. *On an Arsenio-sulphuret of Nickel;* by MM. WACKENRODER and LUDWIG, (Jour. f. Prakt. Ch., xl, 318.)—This ore of nickel occurs massive with spathic iron in graywacke. Analysis afforded the formula $NiS^2+2(Ni, As.)$

36. *On Polymerous isomorphism;* by M. NAUMANN, (Jour. f. Prakt. Ch., xxxix, 196, and xl, 1; Annuaire de Ch., 1848, 142.)—M. Naumann admits that Scheerer's theory explains well the relations of the serpentine of Snarum and chrysolite. But as regards cordierite (iolite) and aspasiolite, it is unsatisfactory; for the constitution of these two minerals requires rather the isomorphism of 1 equivalent of magnesia and 4 of water; and even admitting 5 of water to be isomorphous with 1 of magnesia, there is little discrepancy with the analytical results.

Naumann also shows that the minerals fahlunite, praseolite, chlorophyllite, esmarkite and bonsdorffite do not sustain Scheerer's theory; and to account for their forms, we must admit that they are derived from iolite.

37. *Analysis of California Gold*, (Ann. des Mines, tom. xiv, p. 67; Phil. Mag., May, 1849.)—M. RIVOT, mining engineer, has analyzed a specimen of California gold sent by Mr. Peabody to the Ecole des Mines. The specimen contained—small flattened grains, of a fine yellow color, and extremely small and smooth grains, attracted by the magnet, which appeared to be titaniferous iron. A rather large, yellow and irregularly rounded grain, weighing 0·628 grs., the density of which was only 14·60, was fused on a small cupel in a muffle, and gave a button of alloy, the density of which was 17·48.

The analysis of the grains of gold, performed on one gramme, gave the following results:

Gold, ...	90·70
Silver, ...	8·80
Iron, ...	0·38
	99·88

38. *On some newly discovered Substances from the African Guano Deposits;* by THORNTON J. HERAPATH, Esq., (Quart. Jour. Chem. Soc., April, 1849.)—Some time in the latter part of the year 1845, a paper was read before this Society, by Mr. E. F. Teschemacher,* in which the author gives an account of the results of his analyses, including a variety of substances which had been found in the guano deposits and in their vicinity. Besides those there described, however, I have lately had the opportunity of examining another, which that gentleman does not appear to have taken any notice of. This substance, which was found occurring in large crystalline masses or nodules in a cargo of guano from the island of Ichaboe, on the western coast of Africa, was sent to my father's laboratory for examination by Mr. Ruxton of Swansea, in January, 1846, some of the parties to whom he had supplied the guano having complained to him of the presence of the crystals, imagining them to be an adulteration. These crystals, when purified from the adherent guano, were found to be perfectly transparent and homogeneous, but stained of a light yellowish-brown color by the humic acid and extractive matters of the guano. They were exceedingly frangible, and did not effloresce upon exposure to the air; they dissolved easily both in hot and cold water, and the solutions gave, with the soluble salts of silver, a bright yellow precipitate, which was almost entirely soluble in an excess of nitric acid. When boiled with a solution of potassa, pungent fumes of ammonia were given off, which gave a fugitive stain to moistened turmeric paper. Before the blowpipe, they intumesced, turned black, and gave off water and ammonia; by a further application of heat, the carbonaceous matters were burnt off, and the residue fused into a transparent colorless glass, which dissolved readily in boiling water, giving a solution which yielded a granular precipitate when tested with antimoniate of potash.

The specific gravity of these crystals, as determined by means of oil of turpentine, was about 1·6151. An attempt was made to ascertain the primary form of the crystal, but it was found impossible to do so from the rough irregular masses met with in the guano. By dissolving these, however, in boiling water, and filtering the solution and crystallizing, the salt was obtained in moderately large, colorless, prismatic crystals. Upon subjecting these to analysis, the following results were obtained:

* * * * *

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	Mean.
$\dot{\dot{\dot{P}}}$	..	..	..	..	34·291	34·360	..	..	34·325
$\dot{Na}$			..	..	..	..	16·010	15·494	15·752
NH_3	51·030	52·320	7·540	7·820	..	..	..	..	7·680
$\dot{H}$	..	..	..	..	..	..	..	..	42·243

which very closely corresponds with that of the ammonia-phosphate of soda, or microcosmic salt, the formula for which is

$$\dot{Na}, NH_3, \dot{\dot{\dot{P}}}h + 10\dot{H},$$

or according to Graham,

$$Na\,O, NH_4\,O, PO_5, HO + 8HO.$$

* Mem. Chem. Soc., vol. iii, part 16, p. 13.

The original crystals contained the following constituents in 100 parts as:

Crystallized ammonia-phosphate of soda,	91·660
Organic matters, (urates, humates, &c.)	1·956
Phosphate of potash,	traces.
Chlorid of sodium,	0·520
Carbonate of lime,	0·280
Carbonate of magnesia,	traces.
Phosphate of lime,	2·100
Silica, sand, &c.	2·151
Water and loss,	1·332
	100·000

With regard to the manner of the formation of this salt, it is extremely difficult to comprehend how such a compound as the ammonia-phosphate of soda could be produced by the decomposition of a substance so remarkably deficient in the alkalies as guano. For unless we conceive that there was in this case a peculiar and special source of the soda, we must of necessity admit that it was obtained from the decomposition of the chlorid of sodium of the sea-water by the phosphate of ammonia of the guano—the resulting chlorid of ammonium being either volatilized at the high temperature of those climates, or, from its extreme solubility, dissolved out by the rain-water and carried into the sea or the lower strata of the guano deposits. We well know that chlorid of sodium is capable of being decomposed by phosphate of ammonia at a high temperature. May not this decomposition, therefore, also take place when the salts are in solution? I think it very probable.

This being the first instance in which the ammonia-phosphate of soda has been met with as a natural production, I propose to class it amongst our minerals under the name of "*Stercorite.*"* I should have preferred to have given it that of Guanite, as being more indicative of its origin, but this has been already applied by Mr. Teschemacher to the ammonio-magnesian phosphate, another product of the decomposition of guano.

I have also examined another salt which was met with in the same cargo of guano as the preceding, to which it bore a very close resemblance, both in physical and chemical properties. Like it, it was frangible, crystalline, and readily soluble in water, and gave off ammoniacal fumes when heated to redness or when treated with caustic potash; it also gave a yellow precipitate with nitrate of silver; but it differed from it in efflorescing upon exposure to the air, and in not giving a precipitate with antimoniate of potash.

The primary form of the crystal, as nearly as could be determined from the few imperfect specimens in my possession, was an oblique rhomboidal prism, with a dihedral summit. Upon redissolving these in water and recrystallizing by spontaneous evaporation, long acicular crystals were obtained, which, when dried between pieces of bibulous paper and subjected to analysis, afforded the following results:

* From the Latin "*Stercoro,*" to dung or manure land.

I. 2·131 grains of the crystals, when heated to redness, lost 1·034 grs. in weight of water and ammonia.

II. 1·940 grains gave 6·039 grs. of ammonio-chlorid of platinum =0·465 grs. of ammonia.

III. 3·500 grains gave 10·539 grs. of phosphate of lead, which gave 11·786 grs. of sulphate of lead =1·854 grs. of phosphoric acid.

Or, in 100 parts:

	I.	II.	III.	
Water,	48·521	....	....	23·058
Ammonia,		23·980	....	23·980
Phosphoric acid,	....	....	52·962	52·962

numbers which are very nearly equivalent to 1 atom of ammonia, 1 atom of phosphoric acid, and $1\frac{1}{2}$ atoms of water. It may therefore be considered as the neutral *phosphate of ammonia*. The excess of water was doubtless caused by the moisture which remained between the interstices of the crystals. It was therefore the same salt as that which had been previously examined by Mr. Teschemacher, but which he was prevented from analyzing quantitatively on account of the smallness of the quantity in his possession.

In conclusion, I should perhaps observe that the guano from which the above substances were obtained was exceedingly moist, and possessed a strong ammoniacal smell.

39. *On the probable extent of the Flora of the Coal-Formation in Britain;* by Dr. Hooker, (from a Memoir on the Vegetation of the Carboniferous Period, in Jameson's Jour., vol. xlvi, 1848–49.)—No fewer than 300 species of plants have been enumerated as belonging to the Coal Flora of Great Britain; but, whether this gives any approximation either to what was the amount of species at one period, or even to all those which contribute to form the coal, it is impossible to say. It need hardly be observed, that a collection of the fragments imbedded in our most recent deposits is no index to the general mass of existing vegetation, nor are the remains necessarily those of the commonest plants, or even of such as would *à priori* be judged the best suited for becoming fossilized. That hitherto unknown species do exist in an available state for the botanist cannot be doubted; they are of frequent occurrence; but that these are not so numerous as might be expected from the enormous magnitude of a coal-field, is evident from the great uniformity that prevails throughout the formation. It may indeed be a query, whether the number of species still to be discovered will equal in amount that of the so-called species, which, being founded on imperfect specimens, will ultimately prove to belong to previously described forms.

It cannot be disputed that the vegetation of the carboniferous period, whether confined to the coal-veins or not, was highly luxuriant. The enormous bulk of carbon accumulated, and the prevalence of ferns in all the fields, and the great size to which so many soft-tissued plants attained, all prove this fact. A luxuriant vegetation is, however, no index to a varied one; and, as many of our modern woods, and even great areas of tropical forests, consist of but a few species greatly multiplied, so may the forests of the carboniferous period have been composed of but a few *Sigillariæ* and *Lepidodendrons*, sheltering an

under growth of a limited number of kinds of fern,* for a very limited number of them (comparatively speaking), if as protean as some of their allies are in our day, would embrace all the known species of the Fossil Flora.

In the temperate latitudes particularly, a recent Flora marked by a preponderance of ferns, is almost universally deficient in species or other orders; as is thus shewn. 1. Where one species prevails over a considerable area, as the bracken (*Pteris aquilina*) does in parts of Britain, and the *P. esculenta* in Van Diemens Land and New Zealand, it generally monopolizes the soil, choking plants of a larger growth on the one hand, and admitting no undergrowth of smaller species on the other. 2. A luxuriant vegetation of many species of ferns, continued through a great many degrees of latitude or longitude, especially in the temperate regions of the globe, generally indicates a uniformity of temperature throughout that area, and a paucity of species of flowering plants. A comparison of the vegetation of Tasmania and New Zealand illustrates this. The former of these islands, barely 200 miles long, contains four times as many species of flowering plants as New Zealand, whose total length is 900 miles. On the other hand, this latter country possesses more than four times as many kinds of fern as Tasmania, and they are so uniformly distributed over its area, that almost all those which are found at the southern extremity of the island, prevail also at the northern. The West Indian and Pacific Islands again present a flora, remarkably rich in ferns, and, in both these instances, we have very many of the species uniformly spread over an enormous surface, in the one instance, from the windward Islands to Mexico; and, in the other, from New Zealand to the Society and Sandwich Islands. Take, on the other hand, the campos of Brazil, the sandy flats of Southern Africa, and the somewhat similar plains of Australia, and sterile though they appear at first sight, they will be found to abound in many kinds of flowering plants; but unaccompanied with ferns.

This prevalence of ferns has been long adduced in proof of the climate of the carboniferous period being temperate, equable, and humid; and so, no doubt, it was; but I am not aware that it has been hitherto regarded as probable evidence of the paucity of other plants, and the general poverty of the whole flora which characterized that formation. If, however, the laws of existing vegetation are to be considered as having had equal force at that time when the fossil one flourished, we must conclude that the predominance of ferns in general, and of certain species of Pecopteris (a fern apparently allied to our *Pteris*), over a great area, together with the remarkable similarity of the English fossils with those of North America, are all indications that the flora of that period was poor in number of species.

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* This preponderance of ferns over flowering plants is common to many tropical islands, and not confined to the smaller of them, as St. Helena and the Society group. In extratropical islands, too, as New Zealand, I have collected as many as thirty-six kinds of fern in an area not exceeding a few acres; they gave a most luxuriant aspect to the vegetation, which presented scarcely a dozen flowering plants and trees besides. An equal area in the neighborhood of Sidney (in about the same latitude), would have yielded upwards of 100 flowering plants, and but two or three ferns.

Let it not be supposed that this prevalence of an order, which, in point of complexity of structure, is low in the system of plants, is a fact favorable to the hypothesis that the vegetation of which it appears to form a large part, was less highly developed than what succeeded it. We know too little of the structure of the ferns of that day, to pronounce them either more or less complete than their allies of the present time; while of *Lycopodiaceæ*, it may be safely asserted, that they were of a form and stature far more noble, and in structure more complicated, than any plants of that order now existing. (*Vide* vol. ii, Part 2, of *Memoirs of the Geological Survey of Great Britain.*)

40. *The Himalayan Alpine Land;* by B. H. Hodgson, Esq., (Jameson's Jour., vol. xlvi, p. 189, 1848–49.)—The vast limitary range of snows to the north of India, has been known in all ages by names derived entirely from Sanscrit, the Greeks and Romans neither coining fresh appellations nor even translating the sense of the Indian ones into their own languages, but adopting almost unaltered the Sanscrit names they found. These are Hemáchal, Hema-achal, *snowy mountain;* Hemádri, Hema-adri, the same; Hemálaya, Hema-alaya, *place of snow;* Hemódaya, Hema-údaya, *source of snow;* (as Suryódaya, *source of sun or East.*) From the last term the Greek Œmodus is deduced without alteration. The following tables, shewing the relative height of the great Andean and Himalayan peaks, and the connection of the latter with the physical geography of northern India, may prove interesting, since no one but myself I believe is in a position to note the connection of the snowy peaks with the distribution of waters as regards the eastern half of this magnificent theatre of nature's vastest display.

Andean Peaks.	Feet.	Himalayan Peaks.	Feet.
Sorato, ...	25,400	Nanda Devi, ...	25,749
Illimani, ...	24,350	Dhavala giri, ...	27,060
Desya cassada, ...	19,570	Gosain than, ...	24,700
Descabeçada, ...	21,100	Kanchan Jhinga, . . .	24,000
Chimborazo, ...	21,441	Cholo, ...	26,000

Himalayan Peaks.

Names.	Relations.
No known peak, ...	Basin of the Indus, Alpine Paunjab.
Nanda Devi (above Rohilkhand),	Alpine Gangetic basin, East end. Alpine Karnalic basin, West end.
Dhavalagiri (above Gorakpoor),	Alpine Karnalic basin, East end. Alpine basin of Gandac, West end. Naraini.
Gosainthan vel Dayabhang (above the valley of Nepal), . . .	Alpine basin of Gandac, East end. Trisul. Alpine basin of Cosi, West end, Sún Cosi.
Khanchan Jhinga (above Sikim),	Alpine Basin of Cosi, East end, Tamvar. Alpine basin of Tishta, West end, Bomchu.
Cholo (above Bhutan), ...	Alpine basin of Tista, East end, Painomchu. Alpine basin of Monas, West end, Baréli.

The latter of the above tables shews with distinctness the connection that exists between the greatest elevations of the snowy range and the aquatic system of the Sub-Himalayas, so that the great snow peaks are really entitled to be considered *divortiæ aquarum* on the Indian side of the snows, whatever may be the case on the Tibetan side: and, it is observable that at those points where the transnivean origin of our river necessitates a partial reference of our aquatic system to extra Indian limits, there no such towering snowy peak seems to demark the alpine Sub-Himalayan basin as in cases where our aqueous system is altogether our own and Cisnivean. Thus we have no peak to define the basin of the Indus on its western *or* eastern margin. At least I know of none, though Pargyúl may in part be considered a water-shed, and so, at the other end of the chain, may Chumalari. Both peaks, however, are detached and stand on the plain of Tibet. Cholo is near to Chumalari and not detached. Of the innumerable rivers of these regions the only ones with ascertained transnivean sources are the Indus, Sutlege, Karnáli, Saupu, and Arún, whereof the four first take their rise at Gangri, the great water-shed of the plain of Tibet, close to Lake Mepang vel Manasrovar, and the fifth or Arun from the northern slope of Hemáchal in the district of Tingri. These five rivers are, as might be expected, the largest of the whole, both the Karnali and Arun exceeding the Ganges or Jumna within the mountains, and being nearly equal the one to the other. Gangri is probably the Kailas of the Hindus, whence diverge to the four quarters of the compass the four great rivers of Bhárat des. I have said above that only five of our rivers have trans-Himalayan sources. It is however probable, though unascertained, that the Painomchú and Monas arise beyond the snows, and are identical respectively with the Naivel Pá-chu and the Mon-chú of Klaproth. Chú vel Tchú means river, so that in the one case we have an absolute identity of names, and nearly so in the other (Pá-Pai, the root).

Klaproth's determination to make the Sanpu something else than the Brahmputra, has led him to overlook the several large streams descending into Bhutan and Assam. Had he been aware that his Shokbaja is Sho vel Bhutan, and his Mon vel Moun the Cis-Himalayans generally, he must have been more accessible to recent evidence against his theory.*

With regard to the heights of the Himalayan peaks, of the five given, the two first are Webb's and Herbert's, the third Colebrook's, and the fourth and fifth Waugh's, communicated verbally, the results of his recent operations not having yet been completely worked out. The peak called by me Cholo, Captain W. supposes to be Chumalari; but the natives say otherwise. Captain W.'s positions for triangulation† were at 85 miles distance. Captain Herbert justly observes that unequalled and vast as is the elevation of the giants of Hemachal, no adequate conception of the vast mountain mass can be formed by merely adverting to them. The best way is to contemplate the whole extent and general elevation of the snowy region spreading over some 1800

* Memoirs relatifs à l'Asie 3,370—417, and Map.
† Tanglo and Singchal in Sikim, 10 miles apart.

to 2000 miles, with a breadth or depth of 20 miles, peaks above 5 miles high, distributed throughout *its whole extent*, and passes similarly extended, *yet seldom or never* falling *below* 15,000 *feet;* and all this though we admit Humboldt's somewhat theoretic negation of the general opinion, that Hemachal, and not, as he contends, Kuenlun, is the chain which divides Asia from end to end!

III. Zoology.

1. *Synopsis of the Genera of Gammaracea;* by James D. Dana.—The tribe of Amphipoda among Crustacea includes the subtribes Gammaracea and Hyperiacea. The former of these subtribes consists of six groups or families.

Fam. 1. Orchestidæ. Saltatoriæ. Palpus mandibularis obsoletus. Corpus compressum, epimeris latis. Styli caudales duo postici breviores.

Fam. 2. Gammaridæ. Saltatoriæ vel natatoriæ. Mandibulæ palpigeræ. Corpus sæpius compressum. Antennæ flagello confectæ, non pediformes. Styli caudales duo postici sive longi sive breves.

Fam. 3. Corophidæ. Gressoriæ. Corpus plus minusve depressum, lineare, abdomine recto, normali, epimeris angustissimis vel obsoletis. Mandibula palpigera. Antennæ pediformes.

Fam. 4. Icilidæ. Corpus depressum, latum, abdomine normali, inflexo, pedibus latè expansis instar Araneæ. Antennæ non pediformes.

Fam. 5. Cheluridæ. Corpus vix compressum. Abdomen abnormale, segmentis duobus tribusve coalitis et irregularibus; stylis caudalibus sex, dissimilibus. Antennæ breves pediformes.

Fam. 6. Dulichidæ. Isopodis affines. Corpus depressum, lineare. Antennæ pediformes. Abdomen abnormale, 5-articulatum, stylis duobus. Antennæ pediformes. Pedes tertii quartique breves, sex sequentes elongati, Caprelliformes.

In the following synopsis, the synonymy is included only so far as it is not contained in the work on Crustacea by Milne Edwards (Paris, tome iii, 1840); copious notes also are added. The number of new genera introduced since 1840 is quite large, and a few are instituted from the collections by the writer in the Exploring Expedition.*

We add a word on a single point in the distinctions of genera. The size of the hands among the Orchestidæ and Gammaridæ has often been deemed to some extent an important generic character. But it is now well known that the gradations in the same group are imperceptible, and farther, females may have minute and hardly prehensile feet, while in males of the same species the corresponding hands are quite large. On this ground, Fr. Müller has lately denied the propriety of separating the Orchestiæ, and Talitri (Archiv für Naturg., 1848, p. 53). There is however a wide difference between the species having a styliform joint terminating the *second pair* of legs and those with a hand however minute or obsolescent. The only safe course appears to the writer to consist in drawing the line between *species having a finger or claw however small or large, closing upon the fifth joint,* and those *species having an extended finger or claw not closing up.* Kröyer's *Anonyx*, according to his descrip-

* The Crustacea of the Exploring Expedition under Captain Wilkes will form a volume of text in 4to, accompanied with figures of all the species in a folio atlas. Brief descriptions will from time to time appear in the Proceedings of the American Academy of Arts and Sciences of Boston, part of which, relating to the Entomostraca and including upwards of 150 species, has already been published. The number of new species of Amphipoda in the collections exceeds eighty.

tion, has the 4 anterior feet non-prehensile; but in his figures, these feet are subprehensile though minute, and they resemble in this, many *Amphitoe*, *Orchestiæ*, and *Allorchestes*. The two *anterior* feet of the Talitri vary widely, from an obsolescent hand to a large strong prehensile form. Here as elsewhere in nature, there is no saltus in the gradations to aid us in generic groupings.

The larger part of the new genera recently added, have been instituted by Kröyer from species obtained in high northern latitudes. It is remarkable that the form in this tribe should be so greatly varied in the colder seas, and confined to so few genera in tropical latitudes.

Fam. I. ORCHESTIDÆ.

1. Pedes secundi non subcheliformes. Antennæ superiores basi inferiorum breviores.	*Talitrus* (Latreille).
2. Pedes primi secundique subcheliformes. Antennæ superiores basi inferiorum breviores. Maxillipedes ad apicem obtusi.	*Orchestia* (Leach).
3. Pedes primi secundique subcheliformes. Antennæ superiores breviores, basi inferiorum longiores. Maxillipedes ad apicem unguiculati.	*Allorchestes* (Dana.*)

Fam. II. GAMMARIDÆ.

Sub-fam. I. Lysianassinæ.

Antennæ superiores ad basin crassæ. Epimera grandia. Pedes sex postici non prehensiles.

I. Pedes subcheliformes nulli, secundis interdum exceptis.

a. *Pedes quinti sexti septimique directione similes.*

1. Antennæ superiores appendiculatæ.	*Lysianassa* (M. Edw.).
2. Antennæ superiores non appendiculatæ.	*Phlias* (Guérin).

b. *Pedes quinti tertii quartique directione similes.*

1. Antennæ sup. appendiculatæ. Palpus mandibularis 1-articulatus.	*Stegocephalus*† (Kröyer).

II. Pedes primi subcheliformes, secundi non subcheliformes; reliqui non prehensiles.

1. Antennæ sup. appendiculatæ.	*Opis*‡ (Kröyer).
2. Antennæ sup. non appendiculatæ. Pedes secundi vergiformes; tertii quartique brevissimi.	*Uristes* (Dana).

III. Pedes primi secundique subcheliformes, reliqui non prehensiles.

1. Antennæ sup. appendiculatæ.	*Anonyx*§ (Kröyer).
2. Antennæ sup. non appendiculatæ.	*Stenia* (Dana).

* The species of this genus have the aspect of many Amphitoe, and have probably been hitherto referred to that genus. They have the very short posterior stylets of the Orchestiæ, and resemble them in habit and in the absence of a palpus to the mandible; while they differ in having the superior antennæ *longest* and in the stout spine or claw terminating the maxillipeds. The writer has dissected the mouth of nearly a dozen species of Allorchestes.

† Kröyer's Naturhistorisk Tidsskrift, (Copenhagen,) iv, 150, 1842. "Caput *oculis*, ut videtur, destitutum." "Antennæ breves (capitis altitudine non longiores)." "Pedes quinti paris pedibus tertii quartique paris structurâ et directione similes."

‡ Tids., iv. 149. "Pedes primi paris chelis armati portentosæ magnitudine. Reliqua cum genere *Anonyce* fermè conveniunt."

§ Tids., ii, 256 and iv, 164. This genus is united with Lysianassa by Milne Edwards. Any species wholly without hands are properly *Lysianassæ*; those with only two anterior hands, however minute or imperfect, belong to *Opis*.

IV. Pedes tertii quartique subcheliformes.

1. Antennæ sup. appendiculatæ. Pedes tertii quartique validi, articulo quarto dilatato instar palmæ, ungue conico, aculeato. *Pontoporeia** (Kröyer).

SUBFAM. II. GAMMARINÆ.

Antennæ superiores ad basin tenues. Epimera sive grandia sive angusta. Pedes 6 postici non prehensiles.

I. Pedes subcheliformes nulli, secundis parvulis interdum exceptis.

1. Antennæ superiores appendiculatæ. *Alibrotus* (M. Edw.).
2. Antennæ sup. non appendiculatæ. *Acanthonotus* (Owen).

II. Pedes primi subcheliformes, secundi non subcheliformes, reliqui non prehensiles.

1. Antennæ sup. appendiculatæ. *Leptochirus*† (Zaddach).

III. Pedes primi secundique subcheliformes, reliqui non prehensiles.

A. *Antennæ secundæ subtus primas insitæ.*

* Digiti toti uni-articulati.

a. *Pedes sex postici similes.*

1. Antennæ sup. appendiculatæ. *Gammarus*‡ (Fabr.).
2. Antennæ sup. non appendiculatæ. *Amphithöe*§ (Leach).

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* Tids. iv, 152. "Pedes primi et secundi paris perbreves, robusti; illi manu latâ instructi ungue vero breviore; hi manu carentes ungueque præditi rudimentari. Pedes tertii quartique paris longiores, validi, subcheliformes, articulo quarto dilatato palmam efficiente, ungue armati conico, aculeato. Pedes quinti et sexti paris recurvi, articulo primo parum modo dilatato ungue armati perpusillo. Pedes septimi paris recurvi, articulo primo permagno, clypeiformi; articulo sexto vel ungue rudimentari. Epimera magna."

† Syn. Crust. Pruss. Prodromus, 1844. This genus is stated to be allied to Amphithoe.

‡ From the genus Gammarus, Leach separates:—

MÆRA (Edinb. Encyc., vii, 403; Trans. Linn. Soc., xi, 359.) Manus secundæ valde inæquæ, majore bene cheliformi.

MELITA (Edinb. Encyc., vii, 403.) Digitus pedum secundi paris in latus manûs claudens.

The *Amathia* of Rathke (Fauna der Krym, Mem. Acad. Imp. St. Petersburg, iii, 1837, p. 291, and Beit. zur Fauna Norwegens, Act. Leop., xx Bd.) includes those Gammari which have the superior antennæ shortest—apparently an unimportant distinction.

§ Amphithöe includes the *Dexamine* and *Pherusa* of Leach. *Eusirus* of Kröyer (Tids., N. R., i, 501,) is somewhat peculiar in the form of the hands, but the gradations among the species are such that the character is not sufficient even for a subgenus.

Kröyer's *Microcheles* (Tids., N. R., vol. ii,) is also near Amphithöe. The principal point of difference mentioned is the absence of the molar prominence from the mandible. The *small hands* to which the name alludes is common to many Amphithöes, especially females.

The *Iphimedia* of Rathke (Beit. zur Fauna Norwegens, p. 85; Act. Leop., Bd. xx) appears to differ little from Amphithöe. The superior antennæ are shorter than the inferior, and this characterizes generally the species from the higher latitudes. *Acanthosoma* of Owen (Ross's 2d voyage to the north in 1829–1833, Append., p. xci) has the same characters. The description of Iphimedia by Rathke is as follows—p. 89. "Antennæ superiores inferioribus breviores; illarum pedunculus e tribus, harum e quatuor articulis, compositus: omnium flagellum tenue, multiarticulatum. Pedes secundi paris manibus simplicibus, primi paris, illis minores, chelis instructi, quarum pollex ex uno tantum articulo constat. Reliqui pedes iis Gammarorum similes. Pedes spurii in duos ramos plus minusve complanatos divisi."

b. *Pedes sex postici non similes.*

1. Pedes quinti recurvati, inversi, ungue rudimentari. Antennæ sup. non appendiculatæ. *Photia** (Kröyer).

2. Pedes septimi longissimi, tenues, fere filiformes. Antennæ sup. non appendiculatæ. Frons in rostrum producta. *Œdicerus*† (Kröyer).

† Duo quatuorve digiti bi-articulati.

1. Pedes primi digitum bi-articulati. Antennæ sup. non appendiculatæ. *Leucothöe* (Leach).

2. Pedes secundi digitum bi-articulati. *Erichthonius* (M. Edw.).

3. Pedes primi secundique digitum bi-articulati. Antennæ tenues, sup. appendiculatæ. *Pardalisca*‡ (Kröyer).

B. *Antennæ secundæ post primas insitæ, fronte in rostrum productâ.*

1. Digiti uni-articulati. Pedes 6 postici similes. Antennæ anticæ appendiculatæ. *Ischyroceras* (Kröyer).

IV. Pedes tertii quartique prehensiles; sequentes non prehensiles.

A. *Antennæ secundæ subtus primas insitæ.*

1. Manus tertiæ quartæque simplicissimæ, pollice instructæ. Digiti uni-articulati. Antennæ sup. appendiculatæ. *Lepidactylis*§ (Say).

2. Manus tertiæ quartæque articulis tertio quartoque instructæ, et digiti articulis sequentibus coalitis. Corpus subdepressum. Antennæ sup. appendiculatæ. *Protomedeia*‖ (Kröyer).

3. Manus tertiæ quartæque articulo tertio instructæ, et digiti articulis sequentibus junctis, articulo ultimo longissimo, gracillimo. Antennæ graciles. Epimera magna. *Ampelisca*¶ (Kröyer).

4. Manus tertiæ quartæque articulo quarto instructæ, et digiti articulis quinto sextoque. Corpus subdepressum. Antennæ sup. appendiculatæ; inf. subpediformes. Pedes primi secundique subcheliformes. *Aora*** (Kröyer).

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* Tids., iv, 155. "Corpus sat altum, compressum. Antennæ subpediformes flagello appendiculari destitutæ." "Epimera permagna; quinque paria anteriora ad marginem inferiorem setis sat longis instructa; quintum eadem est ac quartum altitudine, postice profundius excisum."

† Tids., iv, 155. "Frons in rostrum producta, plus minus acutum obtusumve, semper vero nodo pellucente, ovali, flavo rubescente, turgidum. Oculi nulli?" "Pedes primi et secundi paris manu armati subcheliformi permagna. Pedes tertii, quartique paris validi, ungue instructi lato, laminari; quod quoque usu venit quinto sextoque pari, quorum articulus primus dilatatus non est." "Epimera mediocris magnitudinis."

‡ Tids., iv, 153. "Caput crassiusculum, subtumidum. Epimera exiguæ magnitudinis." "Pedes tertii quartique paris ungue sublaminari, posticè subtiliter serrulato. Pedes reliqui elongati, sat debiles, femoribus subangustis."

§ Jour. Acad. Nat. Sci. of Philadelphia, i, 380. Superior antennæ appendiculate, shorter than the inferior pair.

‖ Tids., iv, 154. "Antennæ inferiores pediformes, pedunculo longissimo, flagellum ter ad minus longitudine superante. Pedes secundi paris parvi, manu non instructi subcheliformi." "Epimera sat brevia."

¶ Tids., iv, 154. "Pedes primi secundique paris nulla instructi manu subcheliformi." "Pedes quinti sextique paris articulis modo compositi quinque, quorum ultimus ad finem marginis posterioris ungue armatus est rudimentari, recurvo, immobili (vel parum mobili). Septimum pedum par ungue laminari, lato, natatorio (?)" "Oculi simplices (?)" "Epimera magna." "Sextum pedum abdominalium par natatorium. Reliqua ut in genere Amphithöe."

** Tids., N. R., i, 328, 1845. "Quintum pedum par brevissimum, robustum; sextum par septimumque quinto multo longiora sed graciliora." "Pedes abdominales quarti, quinti et sexti paris saltatorii."

B. *Antennæ secundæ post primas insitæ, fronte in rostrum productâ.*

1. Manus tertiæ quartæque articulis tertio quartoque instructæ, et digiti articulis sequentibus coalitis. Antennæ anticæ appendiculatæ, breves. Pedes primi secundique subcheliformes. *Phoxus** (Kröyer).

SUBFAM. III. ISÆINÆ.

Pedes sex quatuorve postici subprehensiles.

A. *Antennæ secundæ subtus primas insitæ.*

1. *Gammaro* similis. Pedes decem postici similes. Antennæ sup. appendiculatæ. *Isæa* (M. Edw.).

2. Pedes tertii sexti septimique crassè cheliformes; secundi minores; primi quarti quinti minimi. Digiti toti uni-articulati. *Anisopus* (Templeton).

B. *Antennæ secundæ post primas insitæ, fronte in rostrum productâ.*

1. Pedes decem postici subcheliformes, similes. *Laphystius*† (Kröyer).

FAM. III. COROPHIDÆ.

a. *Digiti duo 2-articulati.*

1. Antennæ totæ flagellis confectæ. Caput et segmentum proximum in unum coalita. Pedes quarti, quinti, sextique obsoleti? *Cerapodina* (M. Edw.).

2. Antennæ flagellis carentes. *Cerapus* (Say).

b. *Digiti nulli 2-articulati.*

* Antennæ inferiores flagellis carentes.

1. Pedes secundi non subcheliformes. *Corophium* (Lat.).

2. Pedes primi secundique subcheliformes. *Podocerus*‡ (Leach).

† Antennæ quatuor flagellis gracilibus confectæ.

1. Pedes primi secundique subcheliformes. Antennæ superiores appendiculatæ. *Unciola*§ (Say).

2. Pedes primi secundique subcheliformes. Antennæ superiores non appendiculatæ. *Atylus* (Leach).

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* Tids., iv, 150. "Sextum pedum par ceteris multo longius." "Epimera permagna."

† Tids., iv, 156. "Antennæ sat breves, subulatæ, validæ." "Pes primi paris gracillimus, manu lineari, ungue elongato; pes secundi paris brevis, validus, manu quadrata, ungue sublaminari apice setoso. Reliqui decem pedes validi, subcheliformes, eadem ferme longitudine. Epimera mediocris magnitudinis; quartum par in acumen inferne productum."

‡ The Siphonœcetes of Kröyer (Voy. Scand., etc., 1838–1840, pl. 20, fig. 1; Tids., N. R., i, 481, 1845) differs from Podocerus only in having the posterior legs longer than the four preceding. In his description he says, p. 491:—

"Pedes thoracici primi et 2di paris validissimi, manu instructi subcheliformi. Pedes 3tii et 4ti paris articulo primo latissimo, laminari; articulo quarto obcordato, laminari, manum præbente, cujus unguis efficitur articulo quinto subconico articuloque sexto aciculari. Pedes 5ti 6tique paris minutissimi, sed robusti, recurvati, articulo primo clavato, ungue furcato. Pedes 7mi paris graciles, recurvati, articulo primo laminari, ungue minutissimo, furcato. Pedes abdominales 1mi, 2di et 3tii paris natatorii breves validissimi, parte basali latissima, rhomboidali; pedes 4ti, 5tique paris saltatorii, pes abdominalis sexti paris natatorius unica instructus lamina terminali."

§ Glauconome of Kröyer (ibid, pl. 19, fig. 1; Tids., N. R., i, 491, 1845) has the hands and antennæ of Unciola. The following is the description, p. 501:—

"*Antennæ* subpediformes; superiores flagello ornatæ appendiculari perparvo. *Oculi* minuti, parum distincti. *Mandibulæ* apex in duos fissus ramos qui dentibus

‡ Antennæ longæ, flagello crasso rigidoque, obsoletè articulato.

Antennæ styliformes, rectæ. Pedes filiformes, non prehensiles, sex postici prælongi. *Clydonia* (Dana).

FAM. IV. ICILIDÆ.

1. Pedes postici sublamellati. *Pterygocera* (Lat.).
2. Pedes toti vergiformes, nulli prehensiles. *Icilius* (Dana).

FAM. V. CHELURIDÆ.

Abdomen ad extremitatem crassè styliforme, (segmentis quarto quinto sextoque in articulum styliformem coalitis). *Chelura** (Philippi).

FAM. VI. DULICHIDÆ.

Caprelliformes. Abdomen 5-articulatum. Segmenta thoracis sextum septimumque coalita. *Dulichia*† (Kröyer).

2. *On the Pancreatic Juice;* by M. BERNARD,‡ (L'Institut, No. 791, Feb. 28, 1849.)—Alimentary substances have been arranged by some recent chemists in four groups:—substances soluble by themselves and consequently absorbed directly by the veins and the digestive tube; amylaceous substances converted into sugar; fibrinous matters requiring a special fermentation in order to become soluble; and fatty substances, evidently designed to pass into the chyle and giving it its most decided characters. The recent researches of MM. Bouchardat and Sandras, Mialhe, Bareswill and Bernard himself, have placed beyond doubt the existence of a ferment fitted to change fecula to sugar in some of the liquids which mixed with the aliment. They have shown that the gastric juice has for its primary object the digestion of azotized substances. It remained still to discover the agent operating in the formation of chyle properly so called. M. Bernard argues on the following grounds, suggested by experiments, that this remarkable function belongs to the pancreatic juice.

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sunt armati conicis; tuberculus molaris dentibus confertissimis instructus. *Labium superius* breve, depressum latissimum, margine anteriori medio inciso; *labium inferius* quatuor compositum laminis setosis. *Laminæ maxillares* pedum maxillarium dentibus armatæ validis; unguis palpi apice setosus. *Pes primi paris* robustissimus, manu subcheliformi; pes *secundi* paris gracilior, manu carens subcheliformi, pedes 3tii, 4tique paris pergraciles; pedes 5ti, 6ti, 7mique paris graciles femoribus parum dilatatis. Pedes abdominales 1mi 2di et 3tii paris natatorii, breves sed robustissimi; 4ti, 5tique paris saltatorii, validi; 6ti paris fere rudimentares, natatorii. Epimera minima fere evanescentia."

* Philippi, Archiv fur Naturg., 1839. Also on Chelura terebrans, G. J. Allman, Ann. and Mag. Nat. Hist., xix, 361, June, 1847.

† Kröyer, Tids., N. R., i, 512, 1845, and Voy. Scand., etc., pl. 22, fig. 1, 1*a*–1*n*. "Corpus valde elongatum gracili. Antennæ longissimæ (imprimis superiores) subpediformes; superiores flagello instructæ appendiculari. Oculi prominentissimi, acuminati. Pedes 1mi paris compressi, manu (articulo 4to) magna, ungueque biarticulato instructi (qui unguis articulo 5to 6toque junctis efficitur). Pedes 2di paris manu instructi subcheliformi (quæ apud mares maxima est). Pedes 3tii 4tique paris minimi, fere filiformes, invicem ejusdem fermè longitudine et forma. Pedes 5ti 6ti 7mique paris elongati, lineares (femore non dilatato) prehensiles. Sextus thoracis annulus cum septimo coalitus ut difficilius distinguantur. Epimera nulla vel prorsus rudimentaria. Abdomen quinque modo compositum annulis et quinque præditum pedum paribus, quorum tria anteriora natatoria, duo posteriora saltatoria sunt."

‡ See a notice of a previous memoir, in this Journal, vol. vi, p. 276, 1848.

(1.) The pancreatic juice, when pure and recently formed, emulsionates fats or oils with the greatest facility; the emulsion remains for a long time and the fatty bodies soon undergo a fermentation which separates the acids they contain.

(2.) The chyle begins to be collected in the chyliferous ducts about that part of the intestinal tube where the pancreatic juice is mixed with the alimentary matters.

(3.) When the pancreas are affected, the fatty substances contained in the aliment pass without change into the dejections.

The memoir of M. Bernard has been reported upon favorably by MM. Magendie, Milne Edwards and Dumas, a commission of the Academy of Sciences of Paris.

3. *A description of the characters and habits of Troglodytes gorilla;* by THOMAS S. SAVAGE, M.D., corresponding member of the Boston Society of Natural History; and of the Osteology of the same, by JEFFRIES WYMAN, M.D., Hersey Professor of Anatomy in Harvard University, Boston, 1847, (extracted from the Boston Journal of Natural History.)—We have here another species added to the list of anthropoid animals from the banks of the Gaboon river in Africa, an animal however somewhat inferior in its organization to its well known congener and compatriot the Chimpanzée (*T. niger* of Geoff.) For the first recognition of gorilla (Engé-ena of the natives of Gaboon) as a new species, the scientific world is indebted to Dr. Thomas S. Savage, for many years a missionary resident at Cape Palmas, W. Africa, where he has devoted the best energies of his life to the advancement of the religion of Christ, and has always made it consistent with his duties to lend a helping hand to the cause of science.

Dr. Savage, in April, 1847, first saw two crania which he recognized as distinct from the Chimpanzée, and subsequently obtained two others more perfect as well as other portions of the skeleton. These with such information as he could collect from the natives, the living animal being unknown to the white population, were forwarded to Boston and are the subject of the present memoir, the section on the external characters and habits being by Dr. Savage, the description of the crania and bones, the specific characters derived from them, and general remarks, by Dr. Wyman, and published in November, 1847, in the Boston Journal of Natural History. In Feb., 1848, Prof. Owen of the Royal College of Surgeons, received three other crania of the same species, which he described under the name of *T. Savageii*, in the Proceedings of the Zoological Society of London, New Series, No. 1. As Prof. Owen has added no new specific characters, *T. Savageii* (Owen) becomes merely a synonym with *T. Gorilla* (Savage).

The first memoir of Drs. Savage and Wyman show that the Engé-enas were far more athletic, in all probability, having a height of about six feet, and far more terrible and ferocious than the shy and harmless chimpanzée. Such a belief with regard to their habits exists among the natives, who regard the chimpanzées as possessed of the spirit of a Coastman, and the engé-enas of the more savage spirit of a Bushman. The cranium of the male measured from the plane of the occiput is two inches longer than an ordinary sized human head, and nearly three-quarters of an inch broader across the zygomatic arches. The scapula

and humerus are of gigantic size and are indicative of the immense strength of the arms, which are in relation not only to the arboreal life, but, if the narratives of the natives be correct, to the immense bulk of its body.

The following are the more important of the specific characters enumerated by Dr. Wyman, by which the Engé-ena is distinguished from the Enché-eco or chimpanzée.

1. By its greater size.

2. By the existence of large occipital and interparietal crests in the males.

3. By the great strength and arched form of the zygomatic arches.

5. By the form of the anterior and posterior nasal orifices.

6. By the existence of an emargination on the posterior edge of the hard palate.

7. The incisive alveoli do not project beyond the line of the rest of the face as in the chimpanzée and orangs.

8. The ulna is much shorter than the humerus.

9. The distance between the nasal orifice and the incisive alveoli is less than in the chimpanzée.

This valuable memoir is illustrated by four quarto plates.

IV. Miscellaneous Intelligence.

1. *Telegraphic Operations of the Coast Survey.—Velocity of the Galvanic wave*, (from the Proc. Am. Philos. Soc. Philad., vol. v, p. 74.) —Dr. Patterson, in the name of Prof. A. D. Bache, laid before the Society, an abstract of a report, made by Mr. Sears C. Walker, of the results of the telegraphic operations of the U. S. Coast Survey, made by him on the 23d January last, between Washington and Philadelphia, New York and Cambridge, Mass. A letter from Prof. Bache to Dr. Patterson, accompanying the report, was read by Prof. Kendall.

Washington, March 1, 1849.

Dear Sir,—Will you please communicate to the American Philosophical Society a brief abstract of a Report made to me on the 21st ultimo, of the results of the telegraph operations of the U. S. Coast Survey, made on the 23d of January last, between Washington, Philadelphia, New York and Cambridge, Mass., by Mr. Sears C. Walker, assistant, having charge of the telegraph operations.

The object in view was to test the practical working of the method of imprinting the dates of star transits on a graduated clock register. The three astronomical stations, selected for the occasion, were the Philadelphia Observatory, under the direction of Prof. Kendall; the New York City station, in the private residence of Dr. L. M. Rutherford, under Prof. E. Loomis; and the Harvard Observatory, Cambridge, under Prof. Wm. Cranch Bond.

In conformity with the plan of his Report of December 15, 1849, duplicate records were kept at the Washington Northern Telegraph office, by Mr. Walker and myself.

The astronomical clock was located at Philadelphia, and rated for several days by Prof. Kendall. It contained two tilt-hammer *electrotomes*, one invented by Mr. J. J. Speed, Jr., of Ithaca, N. Y., in 1847

attached to the minute wheel, and giving its signals every two and a half minutes. The other (used for the occasion) was on the plan invented by Dr. Locke, in 1848, and attached to the escapement-wheel. The automatic clock register was graduated to two seconds, usually occupying an inch of paper of the Morse's registering fillet.

Mr. Walker reports, that a comparison of sixty records, made by the two registers at Washington, shows that the probable error of the mechanical operation of printing and reading off, is only about fifteen-thousandths of a second.

This confirms the estimate of accuracy of the work made by him in his report of Dec. 15th last, viz., of a hundredth of a second for the case of an automatic register of single seconds, with an inch of paper to each.

It further appears, from the Report, that when the star-signals were given at Philadelphia, so that the clock and signal-waves had the same local origin, all the registers at all the stations, marked alike, within such limits as were indicated by the probable error just mentioned.

When, however, the star-signals were given at New York, small, but appreciable, differences were noticed in the respective readings of the apparent date of the same event as recorded at the different stations. This discrepancy was still greater for the case of the Cambridge star-signals, the graduating clock always remaining at Philadelphia.

The following table contains the mean excess of the readings of the date of each event in the time of the Philadelphia automatic clock at each station, over that of each of the others, with the number of single results, and the probable accidental error from the source already referred to. The stations compared are denoted by their initials. Those marked *W*, are for the mean of the two records made at Washington. A further revision of these quantities may somewhat change their amounts.

Two kinds of readings were made, viz., *break circuit* signal readings on a *break circuit clock scale*, and *make circuit* signal readings, on a *make circuit clock scale*.

The excess indicated by the mean of the two series of readings for the two scales, with the number of results and probable error of each, are reported as follows. The times A, B, C and D, respectively denote the time of passage of the galvanic wave between W and P, P and N, N and C, C and W.

For reasons connected with the analytical theory of longitudes, by telegraph operations, as published in Mr. Walker's report of Nov. 10, 1847, and in the recent report of the 21st ultimo, the mean of the two series is the most plausible value that can be derived from the printed record. The residual quantities do not appear to be explicable by any admissible value of relative times of operations, of the spiral spring and receiving magnet, armature. Neither do they appear to be explained by any reasonable hypothesis of relative changes of apparent dates from changes of permanent magnetism, as it is called, by change of locality of signal station. The analytical theory of this subject was given by Mr. Walker, Dec. 28, 1847, in his report on the telegraph operations of 1847.

These several sources of error are nearly all eliminated by the manner of forming the residuals of these tables, and being in their nature periodical, disappear in the average of all the results. It may also be

remarked, that the outward and inward armature times of the magnets of the local registers, are relatively annulled by their having the same value for the clock and signal electrotomes.

According to Mr. Walker's report, these residual quantities, from change of relative place of origin of the clock and signal waves, may all be explained by the hypothesis that the time of propagation of the galvanic wave from the place of the clock or star signal stations, to that of the receiving register, though small, is not quite insensible. A solution of the eighteen equations of condition formed on this hypothesis, by Mr. Walker, give, for the velocity of the propagation of the galvanic wave, through the compound circuit, eighteen thousand eight hundred miles per second, with a probable *accidental* error, as stated by him, of about one thousand miles. The statistics are too incomplete to warrant any discrimination between the times of propagation of the wave through the different kinds of media, viz., the wires, the batteries, (three in number,) and the ground. After applying the values of the wave-times by this hypothesis, and with this velocity in the different portions of the whole circuit of one thousand and fifty miles, no sensible discrepancy remains, the residual terms being not greater than the probable errors, from the comparison of the two Washington registers. All the readings now harmonize as well as if all the clock and star signals, and all the printed records, had been made in the same place.

The result is one of much interest to the progress of science, and of special importance in the longitude operations of the coast survey.

The value apparently attributable to wave time, is too great to be neglected in telegraph operations for longitudes intended to be used as data in connection with geodetical measurements. A more extensive series of operations, with more complete mechanical arrangements, will be undertaken in the course of the coming season.

Very truly yours, A. D. Bache.

Dr. R. M. Patterson, Pres. Am. Philos. Society.

Table of Relative Distances.

No.	Star Signal Station.	Receiving Station Compared.	Wave Time.	Relative miles traversed by Clock and Signal Waves.
1	Philadelphia	P – W	0	0
2		P – C	0	0
3		P – N	0	0
4		W – C	0	0
5		W – N	0	0
6		N – C	0	0
7	Cambridge	P – W	A+B+C–D	150
8		P – C	2B+2C	900
9		P – N	2B	400
10		W – C	–A+B+C+D	750
11		W – N	–A+B–C+D	250
12		N – C	2C	500
13	New York	P – W	0	0
14		P – C	2B	400
15		P – N	2B	400
16		W – C	2B	400
17		W – N	2B	400
18		N – C	0	0

Conditional Equations.

No.	Conditional equations, $0=ax+n$,	Weight. W.	Wa.	Wn.	Residual Error, $ax+n=$ ϵ	Probable Error. ϵ'	$W\epsilon\epsilon$
	x			x	x	x	x
1	$0=0 - 0{\cdot}0029$	17	0	$-0{\cdot}0493$	$-0{\cdot}003$	$\pm 0{\cdot}006$	0·00015
2	$=0 - {\cdot}0015$	10	0	$-{\cdot}0150$	$-0{\cdot}002$	7	4
3	$=0 + {\cdot}0038$	8	0	$+{\cdot}0304$	$+0{\cdot}004$	7	13
4	$=0 + {\cdot}0075$	12	0	$+{\cdot}0900$	$+0{\cdot}007$	6	59
5	$=0 - {\cdot}0047$	10	0	$-{\cdot}0470$	$-0{\cdot}005$	7	25
6	$=0 + {\cdot}0070$	5	0	$+{\cdot}0350$	$+0{\cdot}007$	10	2
7	$=1{\cdot}5\times x - {\cdot}0117$	21	31·5	$-{\cdot}2457$	$-0{\cdot}003$	4	19
8	$=9{\cdot}0\times x - {\cdot}0453$	17	153	$-{\cdot}7701$	$+0{\cdot}005$	5	42
9	$=4{\cdot}0\times x - {\cdot}0115$	10	40	$-{\cdot}1150$	$+0{\cdot}011$	7	121
10	$=7{\cdot}5\times x - {\cdot}0386$	24	180	$-{\cdot}9264$	$+0{\cdot}003$	4	22
11	$=2{\cdot}5\times x - {\cdot}0144$	16	40	$-{\cdot}2304$	$+0{\cdot}000$	5	0
12	$=5{\cdot}0\times x - {\cdot}0442$	12	60	$-{\cdot}5304$	$-0{\cdot}016$	6	307
13	$=0 + {\cdot}0007$	9	0	$+{\cdot}0063$	$+0{\cdot}001$	8	1
14	$=4{\cdot}0\times x - {\cdot}0192$	6	24	$-{\cdot}1152$	$+0{\cdot}003$	7	5
15	$=4{\cdot}0\times x - {\cdot}0314$	7	28	$-{\cdot}2198$	$-0{\cdot}008$	8	45
16	$=4{\cdot}0\times x - {\cdot}0225$	8	32	$-{\cdot}1800$	$+0{\cdot}000$	7	0
17	$=4{\cdot}0\times x - {\cdot}0300$	10	40	$-{\cdot}3000$	$-0{\cdot}008$	7	64
18	$=0 + {\cdot}0158$	6	0	$+{\cdot}0948$	$-0{\cdot}014$	0·008	118
		208	628·5	$+3{\cdot}5374$	$-0{\cdot}018$		0·00862
					$\pm 0{\cdot}100$	$\pm 0{\cdot}119$	

Remarks. x=Wave Time for 100 miles. $x=0{\cdot}005629\pm 0{\cdot}000302$. $E=\pm 0{\cdot}00435$, $\frac{10{\cdot}5}{x}=18690$ miles ± 1000 =miles of wave per second. $\Sigma Wnn=0{\cdot}12547$, $\Sigma W\epsilon\epsilon=0{\cdot}00862$.

2. *New Planet*, (N. Y. Jour. of Com., June 11, 1849.)—A new planet was discovered by Signor Gasparis, at Naples, April 12, 1849. It resembles a star of the 9th or 10th magnitude, and its place was near a star on Steinheil's Celestial Chart, in R. A. $12^h\ 9^m\ 49^s$ and S. Decl. $7°\ 0'\ 9''$, and numbered 23,098 in Lalande's Catalogue Reduced. The motion of the planet was retrograde, and towards the equator.

3. *The American Association for the Promotion of Science.*—Agreeable to an invitation from the Corporation of Harvard University, the next meeting of this Association will be holden at Cambridge, commencing on Tuesday, August the 14th. The officers for the ensuing year are as follows.

President.—Prof. Joseph Henry, of Washington.

Treasurer.—Dr. Elwyn, of Philadelphia.

Local Committee for Boston.

Mr. John A. Lowell,
Dr. Jacob Bigelow,
Hon. Nathan Appleton,
Hon. Nathan Hale,
Dr. George B. Emerson,
Prof. H. D. Rogers,
Dr. A. A. Gould.

Local Committee for Cambridge.

Prof. L. Agassiz,
Prof. B. Peirce,
Lieut. C. H. Davis, U.S.N.,
Prof. E. N. Horsford,
Prof. Asa Gray.

Jeffries Wyman, *Secretary.*

Arrangements will be made for the accommodation of the members of the Association, both as regards board and lodging, in Cambridge.

A meeting of unusual interest is expected. This is the second since the change in the character of the Association, by which all branches of science are included. The wide range of its subjects, calls together all who would promote the progress of science in any of its departments; and no place more abounds in attractions, of a scientific, literary or social character than the one chosen for the sessions.

4. *C. G. Page on Galvanic Light*, in a letter to the Editors, dated Washington, D. C., June 13, 1849.—I regret that my letter requesting the suppression of the notice of experiments upon galvanic light, did not reach you in season. The experiment has no other value than a repetition of those made by Prof. Grove, to prove the identity of galvanic with common light in respect to polarization. Dr. Lardner in the course of his lectures in Washington some years since, stated upon the authority of Arago, that galvanic light could not be polarized, and a friend of mine translating for me a communication of De la Rive, gave a similar rendering upon this subject. Upon recurring to the original notice in the Comptes Rendus, I find that the error was committed in translating the French *polarizè*, polarizable instead of polarized, which materially alters the case.

OBITUARY.

5. Julius T. Ducatel.—It is with pain that we have to record, since the issue of our last number, the demise of our old friend and contributor to this Journal, Prof. Ducatel of Baltimore, who expired at his residence, April 23d. We pay a sadly willing tribute to the memory of this man of science, in inscribing here some particulars of his life and character which have been communicated to us by one of his daily acquaintances.

Julius Timoleon Ducatel was born at Baltimore, June 6th, 1796; and was therefore at the time of his death nearly 53 years old. He was the oldest son of the late Eome Ducatel, who a Frenchman by birth, was for a long time the principal pharmaceutist of Baltimore.

Educated at Saint Mary's College, a seminary of learning under the auspices of members of the Order of S. Sulpitius in the Roman Catholic Church, young Ducatel gave evidences of extraordinary facility for acquisition and retention; a faculty characteristic through life.

After his school-discipline was completed, he attached himself for a while to the business of his father's establishment; and subsequently, at the close of the war in 1815, he visited Havana with a view to a mercantile settlement there.

But such pursuits were not congenial either to his physical temperament or his intellectual activity. His propensity was always to be making advances in knowledge; and if he was precluded at any time from acquiring new facts, to devote himself to systematizing and generalizing those already in possession. With these traits, West Indian commerce was hardly likely to thrive in his hands: so he returned home in 1816, after a little more than twelve months' absence, and again took part in the Pharmacy-establishment.

By this time, verging on manhood, the bent of his talents was so decided that the parental wishes which hitherto seemed to find gratification in the prospect of the old house being perpetuated, opposed no farther obstacle to the manifest destiny of the young man; and he was sent to Paris, then as now the focus of the arts and sciences, to complete his education. There, with the appliances which the wealth of his father, chiefly acquired in the exercise of a meritorious profession and honorable skill, freely allowed, he had full opportunity for increasing his stores of learning; and however he may have mixed in the gay societies of the capital, those who knew him best in after life found cause to admire the extent of his graver acquisitions treasured up since then.

There, he made acquaintances whose correspondence was maintained for more than thirty years, and until death rendered it longer impossible; and the names of Brongniart, Brochant, and Gay-Lussac among them, attest the favorable impressions which the young man of five and twenty made upon those whose scientific fame already shook the world.

His stay in the capital of France and his travels through that kingdom, through Switzerland and Italy, covered a period of nearly four years, and having left America in 1818, he returned in 1822. At that time, geology was far from being the systematic science that it is now; but it may be safely said that he brought back with him a knowledge of its as yet somewhat vague groupings, and an acute and accurate appreciation of mineral characteristics, founded not only upon the study of cabinet specimens, but upon extensive and careful observations *in situ*, second to that of none of his American cotemporaries.

Not long after his return, in 1824, he assumed new relations by his marriage with a lady, the least of whose commendations was, that she was a beauty and an heiress. But the fortunes of his family, which had already stood the shock of some unfortunate commercial speculations, were still more seriously impaired by the reverses of 1825–6; and the epoch of his domestic happiness may also be taken to mark a new period, when it became necessary that his talents and learning should be applied in some degree for his own benefit.

His first engagement was as Professor of Natural Philosophy in the Mechanics' Institute of Baltimore; his next as Professor of Chemistry and Geology in the Faculty of Arts and Sciences in the University of Maryland. To both these chairs he manifestly brought extraordinary resources; and, adding to the reputation of a savant that of an agreeable and successful lecturer, he was at length, upon the decease of the lamented Professor De Butts, in 1830, elected with great unanimity to fill the chair of Chemistry in the Medical Department of the University. Here he had a wider scope for his talents; and he is still gratefully remembered by many who enjoyed the benefit of his public teachings, and still more for that abundant accessibility and cheerful interest which he allowed and manifested in the apparatus room to his students. During several years of this period, he also edited awhile alone and awhile in conjunction with C. H. Calvert, Esq., well known by his taste and attainments in German literature especially, a weekly journal, the Baltimore Times, whose subsequent cessation appears to have been caused by the calling away of the editors to other engagements.

In 1832, upon a resolution of the legislature of Maryland in behalf of a new map of the state, he was appointed in conjunction with J. H. Alexander, Esq., to make the necessary preliminary reconnoissance of the subject and the territory. The report of these gentlemen was republished in this Journal, 1st Series, vol. xxvii, p. 1, seqq. Progress was made in this survey; though it was unfortunately hampered by a spirit of well meant but injudicious economy. Prof. Ducatel pursued his researches as geologist (without assistants however) until 1841, when the embarrassments of the state treasury were held to be sufficient reason for suspending any farther appropriation.

This step, however justified by policy in other regards, was in so far unhappy that it deprived the state of results which were upon the point of attainment and the individual of the opportunity of generalizing and assembling the fruits of several years' observation into a shape worthy of science and of himself: for the annual reports, as they themselves testify, were in no wise looked upon by their writer as completing his task for the particular districts of whose examination they respectively treated. They were but popular announcements of particulars of interest especially to the denizens of the respective localities; and regard seems to have been paid in their very style to the exclusion of technicalities whose introduction among the multitude of topics, though it would have thrown over them a scientific garb, would have defeated the proper industrial aim of the report. Yet as they are, they serve to characterize the cautious yet profound spirit of investigation in their author: facts are simply and unpretendingly stated; and the inferences from them when necessary to be drawn are given without any of that theoretical dogmatism which is sometimes met with and which is so much calculated to mislead the reader and ultimately discredit the writer. It is to be hoped that ere long some one will undertake the subject afresh and, bringing up Maryland abreast with Virginia and New Jersey, again enable that state to be among the foremost in the practical applications of geology for which the chemical discoveries and advances in the last seven years have given so much wider scope than was possible in 1833.

During these engagements, Ducatel was also appointed to the Chair of Chemistry, Mineralogy and Geology in St. John's College, Annapolis; a post which in 1838 or 1839 he resigned, as well as his Chair in the University, in order to devote himself more exclusively to his geological examinations. Such devotion although for the best interest of that work, was perhaps not so well for the interest of the individual; since it was the resignation of an *état* in behalf of a temporary employment, and in fact so it proved when a few years afterwards the geological survey was stopped unfinished, and the Professor found himself looking for employment instead of employment unsought pressing itself upon him. If details of this kind are mentioned here, it is with the view of warning others in similar circumstances,—not of course to encourage a selfish disregard of public duties which they may have assumed, but against any implicit and possibly inconvenient reliance upon the measures and consideration of governments which are proverbially ungrateful.

In 1843, Ducatel accompanied his friend Nicollet in an expedition to explore the geology of the Upper Mississippi, and clear up some important points in the theory of volcanic action supposed to have occurred in that region. The premature death of that distinguished man of science prevented the full effect of the coöperation which was designed.

In 1846, he visited the Lake Superior region upon a reconnoissance in behalf of some parties who were proposing industrial developments there: but its only fruit was an interesting series of lectures which he delivered after his return in the winter of that year.

These journies were in so far disastrous in that an accident (he narrowly escaped death on the spot) occurring to him during the first, and a severe illness brought upon an enfeebled frame by exposure during the last, laid the foundation of the physical disorders from which he never afterwards recovered. For some years, his maladies appear to have affected, except at some brief intervals, his capacity for application and exertion; and to have superinduced an unnatural apathy and premature old age. He died of congestion on the lungs; and was interred, as he had always desired, privately in the presence of his family and of a few intimate friends.

As an author, Professor Ducatel but rarely appeared before the world. His principal work, a Manual of Toxicology, was well received and would have been more widely and beneficially known but for a fire which almost cotemporaneous with its publication destroyed all the copies on hand. He laughingly said it was an ill omen and he feared a worse disaster with another edition. His editorial connection with the Baltimore Times has been already mentioned. At a later period, he contributed regularly for some time the scientific articles for the American Farmer and for another journal of wide circulation, the Sporting Magazine.

Enough has been said to shew the character of Ducatel as a scientific man. If his associations are referred to, it is only to shew how he had been appreciated. Always the foremost in every social enterprise where learning and *savoir faire* were required in his native city, the American Philosophical Society of Philadelphia, the Royal Geological Society of Paris, the Georgofili of Florence, and others numbered him among their members.

In another aspect, his temperament rendered him singularly useful in science. No one was more liberal in imparting either what he knew or what he had; the facts he had observed and the specimens he had collected were always accessible and frequently gifts to those he thought would use them well. Those who have themselves commenced the pursuits of science under difficulties will best appreciate and honor such a trait.

His traits as a man were of the same generous and winning character. They will not be dwelt on here; not from fear lest friendly partiality might transcend the severe limits of biographical justice, but that they do not comport with the aim of this notice. The silence of those who knew and loved him is more eloquent than lines of beauty or pages of tenderness. A.

V. Bibliography.

1. *Report in relation to Sugar and Hydrometers:* on researches made under the superintendence of Professor A. D. Bache, by Prof. R. S. McCulloch. Revised edition, published by order of the Senate of the U. S. (Ex. Doc., No. 50, 30th Congress, 1st Session.) Washington, 1848, p. 653.—This voluminous and elaborate report is divided into two parts, as its title indicates, the subjects being entirely distinct and yet quite germane. The first part of the sugar report was issued in 1845–6, and is now reprinted by order of the Senate in connection with the subsequent and more extended research of Prof. McCulloch. To sketch even the scope of these reports would take us quite beyond the limits of a book-notice.

The labors encountered by Prof. McC. and his assistants in these researches, at home and abroad, are evidently very great, and it appears that no care has been spared to probe the several subjects of investigation thoroughly. The method of analysis for saccharine fluids adopted by McCulloch, is that of circular polarization originally indicated by M. Biot. The reasons for this preference are given and comparative results by the ordinary chemical methods. In an extended series of researches like these, embracing nearly two hundred analyses of molasses and sugars, the method of polarization undoubtedly possesses great advantages in every respect, but it may be doubted whether it can replace the chemical methods in ordinary cases, with perhaps imperfect apparatus and an insufficient experience in the use of the instrument and the application of the formulas.

We receive Mr. McCulloch's reports with great satisfaction as substantial and important additions to our previous knowledge, and an additional proof of the wisdom of Congress in consigning special subjects of this sort, involving profound scientific principles, to competent hands for investigation and report, as the only just and enlightened basis of their legislation.

In hydrometers for determining the value of distilled spirits, the results adopted by Prof. McCulloch are entirely in accordance with the opinions and practice of scientific men and of the more intelligent manufacturers, viz., that the centesimal system of notation is the only proper one, founded on a well conducted set of comparisons of actual weights and densities. The report contains ample details on this subject, and tables of results of numerous careful experiments or known mixtures of absolute alcohol and pure water. The results of these sufficient trials will undoubtedly be the adoption, by the revenue laws, of an uniform standard instrument which is much called for by the notorious differences now acknowledged to exist in the methods followed in various parts of the country.

2. *Mohr, Redwood and Proctor's Pharmacy.**—We had scarcely finished a glance at the beautiful London edition of Mohr and Red-

* Practical Pharmacy: the Arrangements, Apparatus and Manipulations of the Pharmaceutical Shop and Laboratory, by Francis Mohr, Ph. D., and Theophilus Redwood. Edited, with extensive additions, by William Proctor, Jr., Prof. of Pharmacy in the Philad. College of Pharmacy. Illustrated by 500 engravings on wood. Philad.: Lea & Blanchard. 1849. pp. 576.

wood's pharmacy, before Prof. Proctor's improved edition of this fine technical treatise was laid on our table by Messrs. Lea & Blanchard. This work is one which will at once find its place in every laboratory and pharmaceutical shop, and is well calculated to recommend new and improved methods of manipulation to both chemists and pharmaceutists. In the absence of highly appointed laboratories and of pharmaceutical instruction which is so general in this country, such works as the present are particularly valuable. The beautiful and abundant wood-cuts which adorn almost every page of the book, render the descriptions of apparatus perfectly plain, and its reconstruction easy even by the tyro. Prof. Proctor has long been known to pharmaceutical readers in this country as the author of numerous and important researches in the Materia Medica, and his additions to the present edition of Mohr and Redwood are frequent and valuable.

3. *Chemical Analysis, Qualitative and Quantitative;* by HENRY M. NOAD, with numerous additions by CAMPBELL MORFIT, with illustrations. Philadelphia: Lindsay & Blackiston. 1840. 12mo, pp. 567.—This well "got up" book is undoubtedly an important addition to the resources of the chemical student, and we believe we hazard little in saying that *England* has produced nothing better. In saying this we do not feel bound to except the late English translation of Rose, by Dr. Normandy, published without the knowledge of its distinguished author, from the *French* edition of 1843; and this too while it is well known to all chemists that Rose is and has been for two years engaged constantly in the preparation of a new and greatly improved edition of his treatise on analysis. Those who are familiar with Rose and Berzelius, will freely acknowledge that all other treatises on analytical chemistry are very largely indebted to these cardinal authors for their most valuable portions.

From this remark we do not except the treatise above named, and it is certainly in itself no poor recommendation of such a work, that its authorities are the best in the literature of chemistry. The difficulty in such cases however, is not that the authorities are good, but that it is not always easy to distinguish the author from the compiler. In general we have to object to this and similar treatises, that they are not always full enough on some important points while they are usually redundant in others. This fault is obvious to experts and with them will do no harm, but to the learner is often troublesome. We frankly confess however, that we have been very favorably disappointed by this book of Mr. Noad's, having contracted a very different opinion of his Lectures of Chemistry, published some years ago.

Mr. Morfit, the American editor, claims our thanks, not only for this edition of Noad, judiciously annotative, but also for his late work on "*Chemical and Pharmaceutical Manipulations*" by the same publishers and in the same size and style as the edition of Noad.

The "Manipulations" is adorned with over four hundred beautiful wood-cuts illustrative of its descriptive portions, and is a really valuable addition to our chemical literature, and should be in the library of all chemical students and manipulators.

4. *The Fossil Footmarks of the United States and the Animals that made them;* by EDWARD HITCHCOCK, D.D., LL.D., President of Am-

herst College, and Professor of Natural Theology and Geology, (from the Transactions of the American Academy of Arts and Sciences, 2d ser., vol. iii, Boston, 1848.)—This elaborate memoir extends to 128 pages quarto, and is illustrated by 24 plates, together with a large table, giving a general view of the distinctive characters of the species. The learned author has pursued the course usual in palæontology, of distinguishing the genera and species *of the animals* indicated by the fossil remains and naming them accordingly. Although the remains are but footmarks, they point out, under the guidance of the unerring principles of comparative anatomy, the habits of the several animals, the classes to which they pertain, and the peculiarities, to some extent, of the species. These characters have been seized, and upon them the descriptions and names are based. Fifty-one species are included in the memoir, 12 of which are of quadrupeds, 4 probably of lizards, 2 chelonian, 6 batrachian, 2 annelids or molluscs, 34 bipeds, 3 doubtful; and of the bipeds 8 were thick-toed tridactylous birds, 16 were narrow toed tridactylous or tetradactylous birds, 2 were batrachian, and the remaining 8 either birds or reptiles and probably the latter. We have to defer to our next number a farther account of the genera and species.

5. *Additional observations on a new living species of Hippopotamus of Western Africa;* by S. G. Morton, M.D., Penn. and Edinb., Vice President Acad. Nat. Sci. Philadelphia, (from the Journal of the Acad. Nat. Sci. of Philadelphia, vol. i, 2d series,) 12 pp. 4to, with 3 plates. Philadelphia, 1849.—This new species of Hippopotamus was first described by Dr. Morton in the Proceedings of the Academy for February, 1844, and there named *H. minor*.* As this name was previously used by Cuvier for a fossil species, it is now changed to *Hippopotamus* (Tetraprotodon) *Liberiensis*. The animal is slow and heavy in its motions and weighs 400 to 700 pounds. It lives on the river St. Paul's, a stream that rises in the mountains of Guinea and passing through the Dey country and Liberia, empties into the Atlantic to the north of Cape Messurado. The description of the animal by Dr. Morton, is drawn from the two skulls in his possession, the only specimens which have hitherto been brought from the African coast.

6. *On the nature of Limbs.* A discourse delivered on Friday, Feb. 9th, at an evening meeting of the Royal Institution of Great Britain. By Richard Owen, F.R.S. London, 1849.—This discourse consists of two portions; in the first of which is demonstrated the "unity of composition" of the limbs of vertebrated animals, their various forms being in accordance with their diversified uses. The paddle of the whale, the short but powerful arm of the mole, the wing of the bat, the fore-leg of the horse and the arm of man, being but modifications of the same typical limb. In all, there exists a shoulder, an arm, a fore-arm and hand; the latter may be provided with its five fingers, as in man and many animals, or it may have a single finger, as in the horse and the apteryx. If the limb form simply an organ of support and of locomotion, then the hand exists in the simple condition of the "fore-foot" of the horse; but if it be prehensory or tactile, it approaches more or less in its conformation, the hand of man. These are views

* See this Journal, xlvii, p. 406, where wood-cuts are given.

however, about which most anatomists have been for a long time agreed, and they have become to a certain extent popular.

In the second portion of the discourse the author grapples with a far more abstruse and difficult subject. Since the publication of the speculations of Gœthe, Oken, Carus in Germany, and of St. Hilaire in France, many attempts have been made to perfect the idea of the philosophical "signification" of the parts of the skeleton. In evidence of the difficulties which beset such investigations, and of the undigested state in which many points still remain, it is only necessary to bear in mind that the two ablest living naturalists have arrived at conclusions widely different. Of their comparative merits however, it is not now proposed to speak. Mr. Owen's views of the "signification of limbs," as set forth in the discourse, are reproduced from his late treatise on the Archetype and Homologies of the Vertebrated skeleton, and this last has its basis on the labors of the German anatomists. One cannot but be struck with the resemblance of Owen's "*Archetypus*" to the "*Schema vom Nerven skelet*" of Carus,* the latter obviously in a very crude embryonic condition; the former giving evidence of more complete development, and provided with appendages of which we do not recognize even the germs in the latter. Mr. Owen, with other transcendental anatomists, regards the whole skeleton as a series of vertebræ, more or less modified, each vertebra consisting of its *centrum* or *body*, an upper or *mural arch* protecting the brain or spinal marrow, and a lower or *hæmal arch* protecting the great blood vessels and the organs of organic life. The lower arch is composed of ribs, their cartilages and sternum, which in the nomenclature of Mr. Owen, are respectively *pleuropophyses*, *hæmapophyses* and *hæmal spine*. In many fishes and reptiles, and in all birds, each inferior arch corresponding with the thorax is provided with a small appendage of bone, which in birds is attached to the middle of the rib, and in reptiles to the point of union of the rib with its cartilage; this Mr. O. calls the *diverging appendage*. Two of these diverging appendages in the Lepidosiren protrude through the muscles, and invested with the common integument constitute its single-rayed pectoral and abdominal fin. From the single-rayed appendages to the acknowledged "arms" and "legs," there are many transitional forms. He therefore regards arms and legs as appendages to ribs and not as modified ribs, as maintained by some anatomists of the transcendental school. The rib to which the arm is attached, consists in the higher vertebrate classes, of the scapula, clavicle and coracoid, one or both of the latter directly attached to the first segment of the sternum, but having no connection with the spinal column; now as every inferior arch corresponds with some centrum, with the "body" of some vertebra, the question at once arises, to what vertebra is the scapula a rib. Mr. Owen reasoning by exclusion, regards it as the true and lawful rib of the occipital vertebra of the cranium. In the skeleton of the crocodile, every vertebra from the atlas to the last lumbar, inclusive, is provided with its inferior arch, or a portion of one, and so are the three anterior vertebræ of the cranium; the occipital being the only one which is destitute of it; if therefore the

* See Carus, von den Ur-theilan, des Knochen- und Schalengerüstes, Tab. IV, fig. 1.

scapula be a rib, it belongs to the occiput, and this view he finds supported by the fact that in most fishes and some reptiles the scapula is directly articulated with the occiput, and this he regards its normal position, and in accordance with this view, avows his conviction, "that in their relation to the vertebrate archetype, the human hands and arms are parts of the head; diverging appendages of the costal or hæmal arch of the occipital segment of the skull."—(Discourse, p. 70.)

Many of the views entertained by Mr. Owen with regard to the homologies of the vertebrate skeleton are original with him, as is also the view just referred to, with regard to the relationship of the anterior extremity to the occiput. Coming from so eminent a naturalist, they should command respectful consideration, but are nevertheless not to be admitted as scientific truths unless resting upon the only sure foundation of knowledge, "observation on the order of nature." It must be remembered that other naturalists have given an entirely different interpretation to the parts in question, and it will, we think, be readily admitted, that a public teacher will not be entitled to consider himself beyond the reach of question, when before a learned audience he indulges in poetical applications of a science, when he avows that he does not regard the "conceivable modifications of the vertebrate archetype as being exhausted by any of the forms that now inhabit the earth, or that are known to have existed here at any former period," and does not think "the inference as to the possibility of the vertebrate type being the basis of the organization of some of the inhabitants of other planets," a "hazardous" one.—Discourse, p. 83.

7. *Report on the Geological Survey of Canada, for the year* 1847–48; by W. E. Logan. 165 pp. 8vo. Montreal, 1849.—This report presents an account by Mr. Logan, of the rocks and minerals along the country south of the St. Lawrence, from Montreal and Lake Champlain to the river Chaudière, and the results of analyses by Mr. T. S. Hunt of several rocks and mineral waters. The general review of the region examined exhibits careful research, and a full knowledge of what is scientifically and practically useful; and it is greatly to the benefit of geological science that the survey has fallen into the hands of Mr. Logan. After many minute and valuable details, describing the rocks, sandstones, limestones, calcareo-chloritic beds, serpentine with intruded trap, he observes as follows:—

"The facts detailed respecting the structure of the Green Mountains in their Canadian prolongation, would appear to make the plumbaginous sandstones and titaniferous red slates of the Seraphine range in the Seigniory of St. Hyacinthe, which are within a mile and a half of the Trenton limestone of that vicinity, equivalent to those of Granby; and these rocks, with their chromiferous calcareo-chloritic bands, to the dolomites and chloritic quartzose rocks of Kingsey, Shipton and Sutton; these again to the serpentine and quartz rocks of Potton, from which it would follow that the whole of the Green Mountain rocks, including those containing the auriferous quartz veins, belong to the Hudson river group, with the possible addition of part of the Shawangunk conglomerates. The fossils of the succeeding micaceo-calcareous formation of Memphramagog Lake and the St. Francis and Famine Rivers would seem to indicate that it is probably of an age not anterior to the Niagara

limestone, or at most the Clinton group beneath, or to use more definite terms, that it is of the upper Silurian series, of which the Clinton group appears at present to be considered the American base; and this sequence would accord with that displayed in the great Appalachian trough, in its nearest approach to the Green Mountain range in the valley of the Hudson. A calcareous formation very fully supplied with upper Silurian remains, has already been mentioned in prior reports, as met with in Gaspé at intervals from the very extremity of that district to Matapedia Lake, a distance of about 150 miles. The geographical character of the intermediate 220 miles, the great similarity in the metamorphic condition of the Notre Dame and Green Mountains, and the continuous run of the recognized rocks of the Hudson River group, from Lake Champlain along the south bank of the St. Lawrence to Cape Rosier, render it probable that the upper Silurian localities will be found to have a nearly direct continuous outcrop connexion; and as the micaceo-calcareous rocks of Memphramagog have I believe been traced thence by Prof. Adams, the state geologist of Vermont, along the eastern flank of the Green Mountains, to the southern boundary of the state near Halifax, whence they proceed into Massachusetts, it seems probable that the upper Silurian group will thus be found continuous perhaps upwards of 700 miles. In Gaspé an arenaceous formation succeeds the upper Silurian, the conditions of which appear to resemble those of the Chemung and Portage group of New York, probably including the old red sandstone; and as this formation in Gaspé is found to possess a thickness of 7000 feet, and in its Western American development does not die away before reaching the banks of the Mississippi, it is not unreasonable to expect that they should follow the upper Silurian zone, in its southwestern course from the eastern extremity of Gaspé, and display a conspicuous figure, either in a metamorphic or unaltered condition, between it and the carboniferous areas of Eastern America, to one of which New Brunswick belongs, while another is met with in the state of Rhode Island, and in a metamorphic condition in Massachusetts. Whether the mica slates southeast of the micaceo-calcareous rocks on the line of section, be part of the Gaspé sandstones in an altered state, can until further investigation, be only conjectural."

On the following pages, the author remarks upon the beds of magnetic and specular oxyds of iron—bog iron and iron ocher—chromic iron, discovered on the 26th lot in the seventh range of Bolton—bog manganese or wad—copper ore—gold and the various rocks of economical importance. The gold of the Chaudière valley was obtained on the banks of a small stream called the Touffe des Pins, a tributary emptying into the right bank of the Chaudière about fifty-eight miles from Quebec. It occurs in the seigniory of Rigaud Vaudreuil, the property of the heirs of the late C. E. Chaussegros de Léry, Esq. The largest pieces collected by Mr. C. de Léry, one of the present proprietors, weigh 1068, 1056 and 744 grains. About 75 lbs. of gravel, washed in the presence of Mr. Logan, produced about two grains of gold to a bushel. A notice of this gold is given in the 6th volume of this Journal, 1848, p. 274, 275.

The results of the analyses of mineral waters by Mr. Hunt, may appear in another number of this Journal.

8. *The Book of the World*, being an account of All Republics, Empires, Kingdoms and Nations, in reference to their Geography, Statistics, Commerce, &c., together with a brief Historical Outline of their Rise, Progress and Present Condition, &c., by RICHARD S. FISHER, M.D., 2 vols. 8vo, 614 and 706 pp. New York, 1849.—This work, as the preface states, is "intended to supply a standard of general reference and a source to which the merchant and scholar may look for the most recent and best authenticated account of the world in its several parts." The first volume, after six pages devoted to general remarks upon the world, is occupied with an account of America, 332 pages of which relate to the United States. The most recent travellers have been consulted with reference to Oregon, California and other parts of Western America. Extensive statistical tables of population, commerce, navigation, navy, army, churches, canals and railroads, &c., are appended to this part of the work. The second volume comprises the countries of the Eastern Continent and Pacific and Antarctic Oceans. The work is illustrated with a chart of the mountains and rivers of the globe; a chart of the national flags of all nations; a chart of the United States, and a chart of the world.

9. *Chemical Technology, or Chemistry applied to the Arts and Manufactures;* by Dr. F. KNAPP, Prof. Univ. Giessen. Translated and edited, with numerous notes and additions, by Dr. EDMUND RONALDO and Dr. THOMAS RICHARDSON. First American edition, with notes and additions, by Prof. WALTER R. JOHNSON. 2 vols. 8vo. Lea & Blanchard: Philadelphia, 1849.—The second volume of this work has just appeared, and is illustrated with 246 engravings on wood, in the first style of the art. The great beauty and fullness of the illustrations, and the general style of printing, recommend the work on the first glance at its pages. This volume treats of glass, alum and vitriol, pottery, brick making, lime, mortar, gypsum, magnesia, and barytes; and all the various modes and means of manufacture and use are detailed, with chemical analyses and a general scientific as well as practical view of the subject. As a specimen of the detail:—to glass 134 pages are devoted, treating of glass and its properties—composition of different kinds—materials and implements for manufacture—manufacture of the different kinds, with minute details and modes of working for the various styles of articles—moulds for pressing glass, and grinding—optical glasses—colored glass—manufacture of smalt—artificial gems—enamel—incrustations, gilding, silvering, &c.—glass spinning, etching, &c.—soluble glass. The other topics are taken up in a similar manner.

10. *Twelve Lectures on Comparative Embryology, delivered before the Lowell Institute in Boston, December and January*, 1848–9; by LOUIS AGASSIZ, Prof. Zool. and Geol. in the Lawrence Scientific School, Cambridge University. 104 pp. 8vo. Boston: Henry Flanders & Co., 1849.—These lectures were reported phonographically, by Mr. James W. Stone, A.M., and we understand, from good authority, that they are faithfully and correctly given. Professor Agassiz for a long time has made this subject his special study, and the science is indebted to him for many important discoveries. Embryology, or the science of egg or animal development, opens to the student the innermost recesses of

the arcana of Life, and develops the unity and harmony of nature from its very foundation. The object of the Lectures is to demonstrate that a natural method of classifying the animal kingdom, may be attained by a comparison of the changes which are passed through by different animals in the course of their development from the egg to the perfect state; the change they undergo being considered as a scale to appreciate the relative position of the species —The subject does not admit of condensation into a few pages, and requires numerous figures for its illustration, and we therefore merely announce the work in this our Bibliography. It is a work of vast learning, and profound philosophical research, and should be read and studied by all who are interested in the laws of Life and the history of animals.

11. *Twelve Lectures on Comparative Physiology, delivered before the Lowell Institute in Boston, January and February*, 1849; by JEFFRIES WYMAN, M.D. 8vo. Boston: Henry Flanders & Co., 1849.—We are indebted for this publication to the accomplished phonographic reporter of Prof. Agassiz's lectures, and their accuracy it is stated, may be equally relied upon. Professor Wyman presents in his series of lectures, a general review of the properties of Living Beings—of Locomotion and the Skeleton—Muscular action—Digestion, Absorption, Circulation and Respiration—Nervous system—and the senses, touch, taste, smell, hearing and vision. The author ranges through the animal kingdom in his illustrations, with a facility which could be accomplished only by a thorough knowledge of natural science in its various departments, and presents his views with clearness and precision. The work is an excellent compend of Comparative Physiology, such a one as the student needs; and the learned reader will value it for many original views and much recent information.

12. *Pioneer History, being a brief account of the first examinations of the Ohio Valley and the early settlement of the Northwest Territory, chiefly from original manuscripts, &c.*; by S. P. HILDRETH of Marietta, Ohio. Cincinnati, 1848, pp. 525, 8vo.—Although this work is not devoted to science, its learned and excellent author has done so much for its cause, as is manifest in many volumes of this Journal, that we are not willing to deny ourselves the pleasure of mentioning in our pages this interesting and instructive history of the settlement of a very important part of the United States.

Sixty years have hardly elapsed since the first permanent settlement was made on the banks of the Ohio below the confluence at Pittsburgh of its two constituent rivers, the Monongahela and Alleghany. Now the state of Ohio alone contains two millions of inhabitants, and is one of the most flourishing and progressive states in the Union; and six or seven other powerful states lying still to the west have already extended the chain so far, that a link or two more will carry it to the Pacific Ocean.

Dr. Hildreth was an early pioneer in Ohio—not an actor in the sanguinary conflicts with the aborigines, nor a sufferer in the periods of severe privations of almost every kind, of which starvation—proceeding to great suffering if not to actual death—was the chief. He was however early enough on the ground to draw much valuable information from several of the first adventurers who were still living, and he

has fully availed himself of many other original sources of information in private journals, correspondence, the records of the Ohio Company, &c. He has rescued from oblivion many biographical notices, connected with events of deep and thrilling interest, and through his pages many individuals may trace out their own family history. To them and to all persons interested in the history of the West, this work of Dr. Hildreth is invaluable, nor can it be read by any American without a feeling of deep sympathy for the sufferings of the early settlers, and admiration of their heroism—as well as social and personal virtues. Even the writer of this notice can remember the disastrous battles of Harmar and St. Clair, and the decisive victory of Wayne—nor has the bruit of savage massacre which floated on every western gale yet died away. We do not know of any American history, except that of the valley of Wyoming by Mr. Charles Miner, which equals in painful interest this recent work of Dr. Hildreth. Both are replete with stories of tragical conflicts and almost unparalleled sufferings—strongly set forth by men of high intelligence and worth—and our only consolation in perusing such painful narratives is, that both the valleys of the Ohio and of the Susquehannah are now smiling in peace, comfort and plenty, while the grass grows and the plough traces its furrows over the graves of the slaughtered pioneers and through soil once wet with their blood.

13. *The Earth and Man: Lectures on Comparative Physical Geography in its relation to the History of Mankind;* by Arnold Guyot, Prof. Phys. Geog. and Hist., Neufchatel, Switzerland. Translated from the French by C. C. Felton, Prof. Harvard Univ. 310 pp. 12mo. Boston, 1849.—A copy of this volume reached us at too late an hour for an extended notice. The work is one of high merit, exhibiting a wide range of knowledge, great research, and a philosophical spirit of investigation. Its perusal will well repay the most learned in such subjects, and give new views to all, of man's relation to the globe he inhabits.

14. *Système Silurien du Centre de la Bohéme;* by Joachim Barrande. In 3 volumes, 4to. The first two for Palæontology, the third Geology. Pr. 100 fl. C. M.—This work has been recently announced as in course of publication, and subscriptions are solicited, which may be addressed to W. Haidinger, Wien (Vienna). It will contain 130 to 140 plates, illustrating one thousand species. The work is mentioned to us as an exceedingly important contribution to science, and of peculiar value to American geologists on account of the wide extent of the Silurian strata in the United States.

15. *Third Annual Report of the Board of Regents of the Smithsonian Institution to the Senate and House of Representatives, showing the Operations, Expenditures and conditions of the Institution during the year* 1848. 64 pp. 8vo. Washington, 1849.—This Report states among its many facts of interest, that the Institution has been the means of starting an important literary enterprise. Mr. Henry Stevens, who has been engaged for a number of years as agent in this country of the British Museum and other European libraries, has commenced the preparation of a bibliographical work comprising a description of all books relative to, or published in, America prior to the year 1700, and

indicating not only the contents and value of the books, but also the principal libraries in this and other countries where they are to be found. Mr. Stevens has already commenced his investigations in foreign libraries. This gentleman is well known to be fully competent for the task, though so arduous and difficult in its nature.

16. *Manual of Mineralogy or the Natural History of the Mineral Kingdom;* by JAMES NICOL, F.R.S.E., F.G.S., Assist. Sec. Geol. Soc. London.—576 pp. 12mo. *Edinburgh.* 1849.—This manual of mineralogy is a thorough, accurate work, well worked up to the period of its publication. It is very full in analyses and sufficiently so in notices of localities. Naumann's system of crystallography and crystallographic notation are adopted throughout, and under each species, the system of crystallization with the notation of the common forms are mentioned; but few angles are given and figures are but sparingly introduced. The classification is a mixed system approaching in its general features that of Mohs. It is as follows—

I Order. OXYDIZED STONES. *Families:* Quartz, Feldspar, Scapolite, Haloid stones, Zeolite, Mica, Hornblende, Clays, Garnet, Gems, Metallic stones.

II Order. SALINE STONES. *Families:* Calc spar, Fluor spar, Heavy spar, Gypsum, Rock salt.

III Order. SALINE ORES. *Families:* Sparry Iron ores, Copper salts, Lead salts.

IV Order. OXYDIZED ORES. *Families:* Iron ores, Tinstone, Manganese ores, Red Copper ores, White Antimony ores.

V Order. NATIVE METALS.

VI Order. SULPHURETED METALS. *Families:* Iron pyrites, Galena, Grey Antimony ore, Grey Copper ore, Blende, Ruby-blende.

VII Order. INFLAMMABLES. *Families:* Sulphur, Diamond, Coal, Mineral Resins, Combustible salts.

ISAAC LEA: Observations on the genus Unio, together with descriptions of new species in the families Naiades, Colimacea, Lymnacea, Melaniana, and Peristomiana, with numerous plates. Vol. iv. *Philadelphia.*

SEARS C. WALKER: Ephemeris of the Planet Neptune, from the data of the Lalande Observations of May 8 and 10, 1795, and for the oppositions of 1846, 1847, 1848, and 1849, computed for the Smithsonian Institution. Appendix I to vol. II, of the Smithsonian Contributions to Knowledge, 32 pp. 4to. *Washington,* 1849.

FOURTEENTH REPORT of the Chester Co. Cabinet of Natural Science, March 17, 1849, 8 pp. 8vo. *West Chester, Penn.,* 1849.

Dr. ED. SCHWEIZER: Praktische Anleitung zur Ausführung quantitativer chemischer Analysen, mit einem Vorworte von Prof. Dr. Löwig. Mit vielen in den Text eingedruckten Holzschnitten. 10 Bogen. 8 broch.

W. SARTORIUS VON WALTERSHAUSEN: Atlas der Ætna. *Göttingen.*

V. STREFFLEUR: Die Entstehung der Kontinente und Gebirge unter dem Einflusse der Notazion nebst einer Uebersicht der Geschichte des Europäischen Bodens in geognostisch-orographischer Beziehung; mit einem kolorirten Atlasse. *Vienna.*

Dr. A. SCHNIZLEIN and ALBERT FRICKHINGER: Vegetations-Verhaltnisse der Jura und Keuperformation in dem Flussgebieten der Wornitz uud Altmühl; mit einer geognostisch-topographischen Karte des Bezirkes. *Nördlingen,* 1848.

H. G. BRONN: Lethæa Geognostica. Dritte Auflage. Erste bis dritte Lieferung, Tafel I–XL. Preis fl. 10, 12 kr. R. 6. 11 sgr.

J. J. KAUP and Dr. H. G. BRONN: Abhandlungen über die gavial-artigen Reptilien der Lias formation. Mit 4 lithographirten Tafeln in 9 Blättern und 1 Vignette. Preis fl. 5. R. 3. 5 sgr. Nachtrag hierzu von Dr. H. G. Bronn, mit 2 liththog. Taf. Preis fl. 3. R. 1. 22½ sgr.

PROCEEDINGS BOSTON SOC. NAT. HISTORY. NOVEMBER, 1848. p. 81. Closing of straits on east end of Long Island Sound, and a change to fresh water ponds with fresh water animals; *Dr. Cabot.*—p. 83. Shells of the U. S. Exploring Expedition (6 species of Littorina, 1 of Stilifer, 1 of Solarium); *A. A. Gould.*—DECEMBER. p. 85. On the ovarian egg; *Desor.*—p. 87. On the muscular arrangement in Catostomus; *Mr. Ayres.*—p. 89. Shells of the U. S. Exploring Expedition (3 of Turbo, 8 of Trochus); *A. A. Gould.* On fresh water in Dune Sands and Sand Spits; *E. C. Cabot.*—p. 96. On Arkansite, Schorlomite and Ozarkite of Shepard; *J. D. Whitney.*—JANUARY, 1849. p. 99. On certain dendritic delineations; *Mr. Teschemacher.*—p. 100. On Chloritoid and Masonite; *J. D. Whitney.*—p. 102. On the black Oxyd of Copper of Copper Harbor, Lake Superior; *J. D. Whitney.*—p. 103. On fresh water in dune sands; *E. C. Cabot* and *Mr. Ayres.*—p. 108. Shells of the U. S. Exploring Expedition (8 species of Trochus); *A. A. Gould.*—p. 108. On the distribution of animal life about the shoals of Nantucket; *Desor.*—FEBRUARY. p. 111. Geological position of the Mastodon giganteus.

PROCEEDINGS OF THE AMERICAN PHIL. SOC. PHILAD.—Vol. v, No. 42. Jan., March, 1849.—p. 51. Markings by Telegraphic Clock; *John Locke.*—p. 54. On the U. S. Coast Survey.—p. 74. Telegraphic Astronomical Clock, and velocity of galvanic wave (see this volume, page 142).

ANNALES DES SCIENCES NATURELLES, Paris, JULY, 1848.—On Annelida (family "Hermelliens"); *A. de Quatrefages.*—New Paguri; *Milne Edwards.*—Review of the genus Cinchona; *H. A. Weddell.*—On Anatomic Phyllotaxy or Researches on the Organic causes of the different distributions of leaves; *Th. Lestiboudois.*—AUGUST. On Corals; *M. Edwards* and *Jules Haime.*—On the hours of waking and singing of some birds during the months of May and June, 1846; *D. de la Malle.*—Anatomic Phyllotaxy, continued; *Th. Lestiboudois.* New exotic cellular plants; *C. Montagne.*—SEPTEMBER. On the Gasteropoda Phlebenterata; *A. de Quatrefages.*—On Coleoptera of the Genus Eurhinus (Curculionidæ); *E. Blanchard.*—Sur le nonvomissement du Cheval; *M. Flourens.*—Embryogeny of the Annelida; *A. de Quatrefages.*—New exotic Cellular plants, continued; *C. Montagne.*—Anatomical Phyllotaxy, continued; *Th. Lestiboudois.*—On the Family Salvadoraceæ; *J. E. Planchon.*—OCTOBER. Embryogeny of the Annelida, continued; *A. de Quatrefages.*—Vertebrata of Algiers, viewed in relation to zoological geography and domestication; *P. Gervais.*—On Corals; *M. Edwards* and *Jules Haime,* (4th mem. Monographie des Astræidæ).—Changes in the flora of Central Europe during the tertiary period; *V. Raulin.*—On the Embryos which have been described as Polycotyledonous; *M. Duchartre.*—On the Ovula of the Euphrasia officinalis; *G. Dickie.*—On the Ulmaceæ as a tribe of the Urticeæ; *J. E. Planchon.*

APPENDIX.—At a late hour we have received the following letter from Mr. ISAAC LEA, (dated Philadelphia, June 17,) on footprints in Pennsylvania in rocks below the coal; a further notice is necessarily deferred to our next number.

"I am sure it will greatly interest you to learn that it has been my good fortune to have discovered "fossil footmarks" of a *reptilian quadruped* in the series below any heretofore observed. In a late visit to the southern coal field of Pennsylvania, while making some geological investigations, I found six distinct double impressions in regular progression, in the OLD RED SANDSTONE. These were accompanied by numerous "ripple marks" and "pits of rain drops" over the whole exposed surface of the rock. The lowest heretofore observed I believe are of the *Chirotherium*, described by Dr. King in the coal formation, near Greensburg, Pa., and those mentioned by Dr. Logan, in the same formation of Nova Scotia.

"The name I have proposed for this reptile is *Sauropus primævus.*"